POWER

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The Five-Day Week

BENJAMIN FRANKLIN estimated that if everybody did his share, the world's work could be done in four hours per day.

But the world was not living at that time at the rate or upon anything like the plane that it is now.

All of the then available manpower working the long hours to which they were then accustomed could not have provided the population with the comforts and conveniences and cultural advantages that they now enjoy.

It has taken a century and a half of invention and discovery and enterprise and development to bring the returns of the day's labor up to the present stage.

With power-driven machinery, with improved methods of material handling and transportation, with new materials and processes, the producing capacity of labor has been enormously increased.

And so we have seen a gradual reduction in the length of the working day.

In many trades and businesses the working week has long been reduced to five and one-half days. In the case of the McGraw-Hill Publishing Co., Inc., this has been reduced to five days during the summer months. Henry Ford has adopted the five-day week regularly, and now comes the announcement of the president of the American Federation of Labor that it will strive for the general adoption of the practice.

This is better than further shortening the day. If it takes one an hour to get to work and an hour to get back home, a quarter of his time on the job is used up in going to and fro if he works eight hours. If he worked six, one-third of his working time would be used up on the road.

Of course the shortened week reduces the load factor of the works and increases the overhead per unit of working time, but if labor fulfills its promise of doing as much in five days as in six, the overhead per unit of production will not be increased.

Many of the industries, too, are over-equipped. There are too many factories and too much machinery to do the work of the world if all were run full time at full capacity.

A New Yorker entertaining a Chinaman, rushed him aboard a subway train and, apologizing for hurrying him, remarked that by catching that train they had saved five minutes. "And now," asked the Oriental blandly, "what are you going to do with it?"

Now that we have, or are going to have this extra time, what are we going to do with it?

F. R. Low

Coal Preparation and Handling at Trenton Channel

By JOSEPH H. DRAKE
Boiler-Room Engineer at Trenton Channel Station,
Detroit Edison Company

OPERATING experience with the coal preparation and handling equipment from the car unloader to the burners. A second article, to appear next week, will follow through the burners, take up the control and discuss the wear on various parts of the pulverizing system.

TRENTON Channel Station, the latest addition to the group of power plants forming the backbone of the Detroit Edison system, is situated on the Detroit River, about eighteen miles south of the center of Detroit and is designed to serve the southern manufacturing and residential sections and to be a link in the 120,000-volt transmission line forming a semicircle around Detroit. It is the first of the company's plants equipped to burn pulverized coal, and consequently there is more than normal interest evidenced in its operating and economic performance. At present there are in operation three 50,000-kw. turbo-generator units and eight Stirling boilers, each having 29,087 sq.ft. of heating surface, and construction is in progress on two additional turbo-generators and three more boilers. A previous article in *Power* (May 27, 1924) covered a general description of the plant in detail.

Crushed-Coal Handling

Coal is delivered to the plant by rail only. Reserve stock is carried in the yard, 30,000 tons per turbo-generator unit being held in stock under normal conditions. The unloading house and the mill house containing coal-handling equipment, pulverizing machinery and 2,500-ton crushed coal bunkers are separate from the boiler house except for two bridges, the only connection for coal being through two 8-in. lines delivering pulverized coal from the Fuller Kinyon pumps to the pulverized coal bins at the boilers.

Coal is weighed at a scale house in the yard and delivered by locomotive to the track hoppers in the unloading house, where it is removed from the cars by a special type unloader. It is elevated from the unloading hoppers by two 160-ton apron conveyors to a Bradford breaker of 320 tons capacity, which reduces it to a fineness of 1¼-in. or less and it is carried then by two apron conveyors to bucket elevators. The bucket elevators make a vertical circuit around the mill house and dump the coal to a 36-in. belt conveyor equipped with a magnetic pulley. It is discharged from the magnetic pulley to a shuttle belt that distributes it to any one of seven crushed-coal bunkers.

Fig. 3 shows the unloader, which is of special design. It is constructed to span a track above the coal cars as they stand over the unloading pits and is capable of being moved the length of the unloading pits. The unloader is equipped with spuds which can be lowered to the bottom of the car, and the movement of the unloader along its track above the cars acts to scrape the coal from the ends of the car toward the

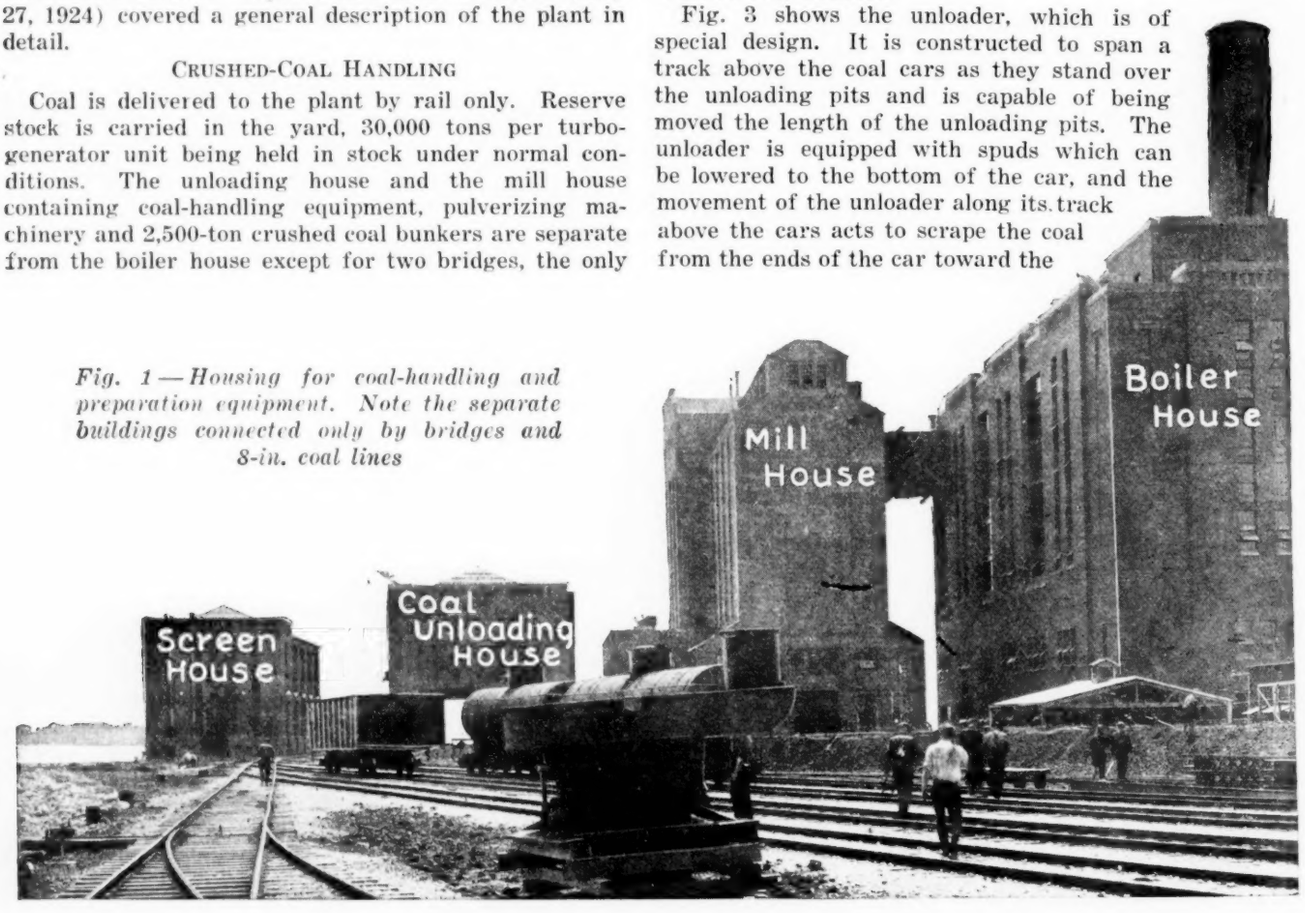


Fig. 1 — Housing for coal-handling and preparation equipment. Note the separate buildings connected only by bridges and 8-in. coal lines

open hopper doors at the center. The unloader is useful only for cars with doors at the bottom. It is equipped with compressed-air-operated hammers, or spuds, for use in breaking up frozen coal. The unloading house is furnished with a steam line and hose for application to coal frozen so badly that the hammers on the unloader cannot break it. The original coal unloading machine of this type was described by J. P. Considine, its designer, in *Power* for Oct. 12, 1915, p. 502.

From the long apron conveyors the coal is dropped onto grizzlies to break up the larger pieces, and down a screen inclined toward the inlet of the coal breaker, shown in Fig. 4. The coal of less than 1¼-in. size drops through the screen and into one of the hoppers underneath the breaker without going through the breaker itself. The remainder goes into the end of the breaker, elevator and picking belt. Instead, a man is sent into the breaker twice a day or more often if necessary, to remove the tramp iron, etc. Incidentally, this gives the opportunity for a twice daily inspection of the breaker, which is desirable on account of the possibility of loose bolts, deflector plates or bars.

After a short period of operation of the breaker, it became evident that most of the work was being done toward the inlet side and that a greater portion of the coal was dropped into the first hopper underneath the breaker. The hoppers being close to the under side of the breaker, coal would not spread readily from one hopper to the other, and some other means had to be devised for more even loading of the short apron conveyors that remove the coal from the hoppers under the breaker. A deflector plate was put in between the

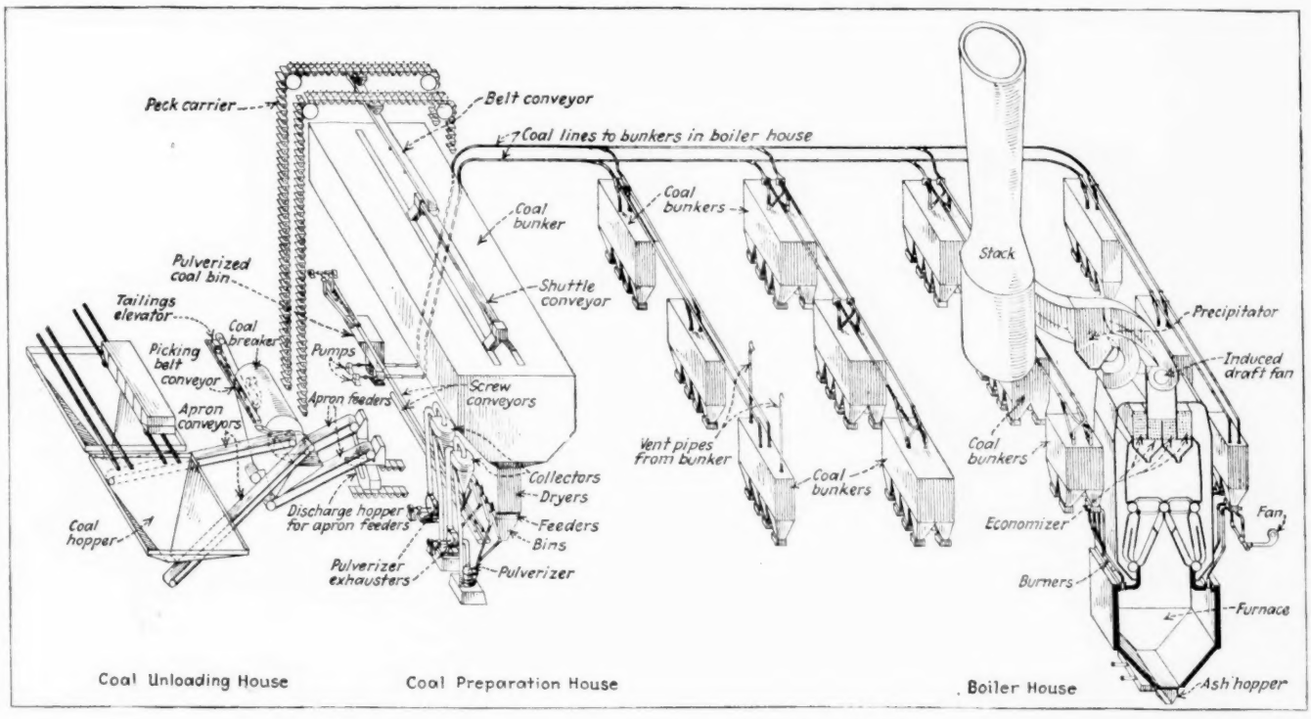


Fig. 2—Isometric view of coal-handling system

where the rotating action, together with lifting bars and deflector plates, raises the coal, drops it and moves it toward the discharge end. As it breaks up, it drops through the numerous perforations in the cylinder wall of the breaker to two hoppers immediately below. Any tramp iron, wood or other foreign matter that cannot get through the holes in the breaker goes to the far end. This end was originally open to a tailings elevator that elevated the foreign matter and the coal that was not broken up, to a picking belt discharging in turn into the inlet side of the breaker. A man stood at the picking belt and threw out everything that came by except the coal, which was allowed to return to the breaker.

However, it was hard to make a joint between the end of the breaker and the tailings elevator that would not allow some foreign matter to get into the hopper below the breaker; also, any large piece of iron was liable to become caught in the spokes of the breaker or in the discharge chute to the tailings elevator. For these reasons it was decided to blank off the end of the breaker and to discontinue the use of the tailings two hoppers, and the screens were blanked off in an attempt to load evenly the two short apron conveyors. This method was partly successful, but the varying condition of the coal as it comes from the mines still results in uneven loading at times. The design for the second section of the plant is changed so that the apron conveyors run horizontally and parallel to the longitudinal axis of the breaker. This will permit control of the loading of the conveyors.

The breaker drive is equipped with a clutch, but it has been found that the use of it is not required and it has been set permanently in the engaged position and is not used in operation.

At the discharge end of the breaker is an opening leading to a breaker exhauster fan, Fig. 5. This fan picks up part of the coal dust generated at this point and discharges to a cyclone separator over the coal-pump hoppers. The air is returned to the inlet side of the breaker, and the coal dust is delivered to the pulverized-coal-pump hopper. It is estimated from observations that this fan and separator furnish approximately four tons of pulverized coal per hour

to the coal pumps, during the time that the coal-handling machinery is in operation.

Short apron conveyors receive coal from the two hoppers at the bottom of the breaker and deliver to a chute designed to discharge to either of two bucket elevators. Several trials made on the loading of the buckets indicated that a partly restricted opening, giving a flow parallel to the direction of travel of the buckets, gave the best results. There is still, however, some slight spillage of coal from the buckets, as well as some from the point where the breaker discharges to the short apron conveyors.

Running to the top of the building, the bucket elevator is tripped into a stationary belt conveyor equipped at the discharge end with a magnetic pulley. The magnetic pulley has been quite successful, but does not remove all the iron, so that a small amount gets through to the mills.

From the stationary belt conveyor the coal is delivered to a shuttle belt that can be run in either direction and also moved along a track, enabling it to deliver coal to any of the seven bunkers. There has been no trouble with the bunkers, other than the crushing of the first inspection ladders installed, which were too light to withstand the action of the moving coal. The bunkers are emptied, cleaned and inspected three or four times a year.

Steam-Grid Driers

Driers of the stationary steam-grid type are located just beneath the crushed-coal bunkers and are fed by gravity. One side of each drier is open to atmosphere, and the other discharges to a common duct in which a slight negative air pressure is maintained by an exhauster fan. The combined heating with steam in the hollow grids forming the drier proper and the draft of air through the coal in the drier, give the reduction of moisture desired before delivery to the pulverizing mills. From the drier duct the air is drawn through a washer to remove the coal dust and is discharged by the fan to a vent on the roof of the building. The dust removed is run down to a special sump.

Washing has thus far proved to be the only effective and feasible means for removing this fine coal dust from the air. Electrostatic precipitation is not applicable to dust consisting of an electrical conducting material.

Each drier is made up of a stack or nest of grids, so arranged that as the coal passes down, it will be in contact with a larger percentage of the area heated by steam flowing through the cored-out grid sections. As shown in Fig. 7, the drier grids are triangular in cross-section with the pointed edges up. They have given practically no trouble from hanging up of coal in the driers. The open spaces occurring just beneath the triangular grid sections are believed to give the necessary freedom for preventing the tendency to bridge across.

Once a month the driers are emptied and inspected. The duct back of them, through which the air from the driers and the mill vents is exhausted, is inspected before starting up the mills and is cleaned out three times a week to guard against the possibility of fire. The opening from each drier to the duct can be closed by louvers and doors, so that when a mill is down for repair, the drier can be emptied and isolated to prevent a short-circuit of air through the empty drier.

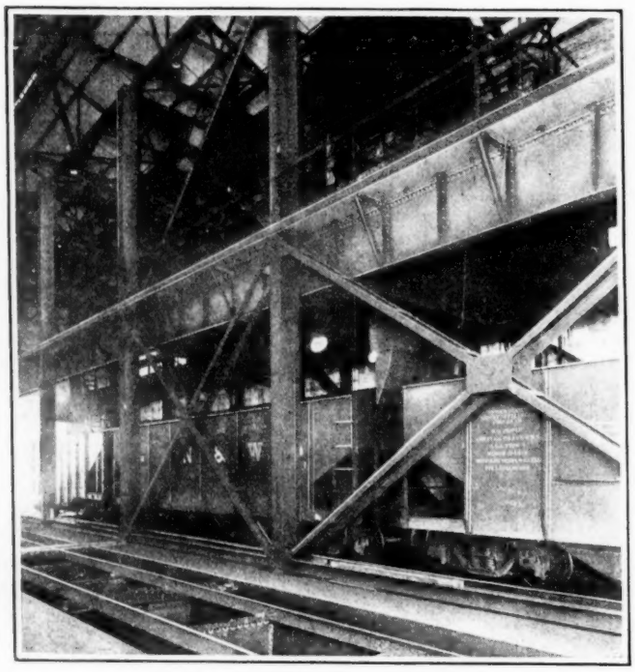
At present the driers are not baffled, but as a series of tests indicated that baffling to force the air to take a longer path through the coal is desirable, it is probable that baffles will be installed.

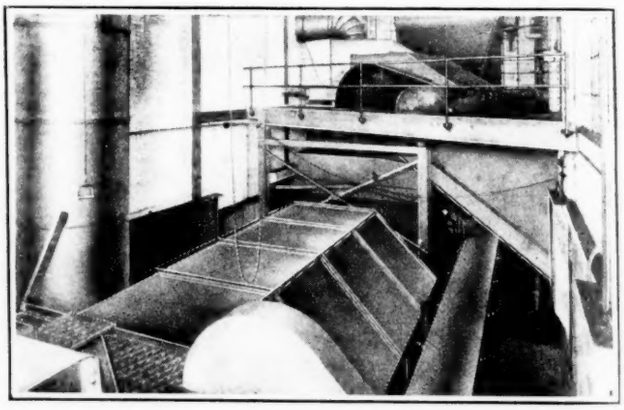
In operation the steam is turned into the driers and

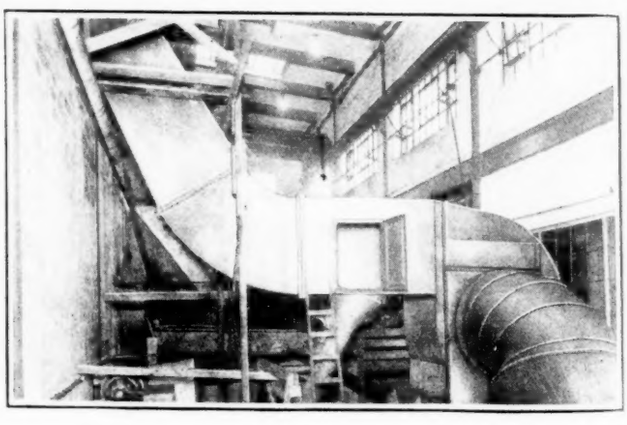
Fig. 3 (Below)—Coal unloader above coal cars equipped with scraping spuds

Fig. 4 (Upper right)—The Bradford breaker has a capacity of 320 tons

Fig. 5 (Lower right)—Exhauster fan for removal of dust generated in breaker







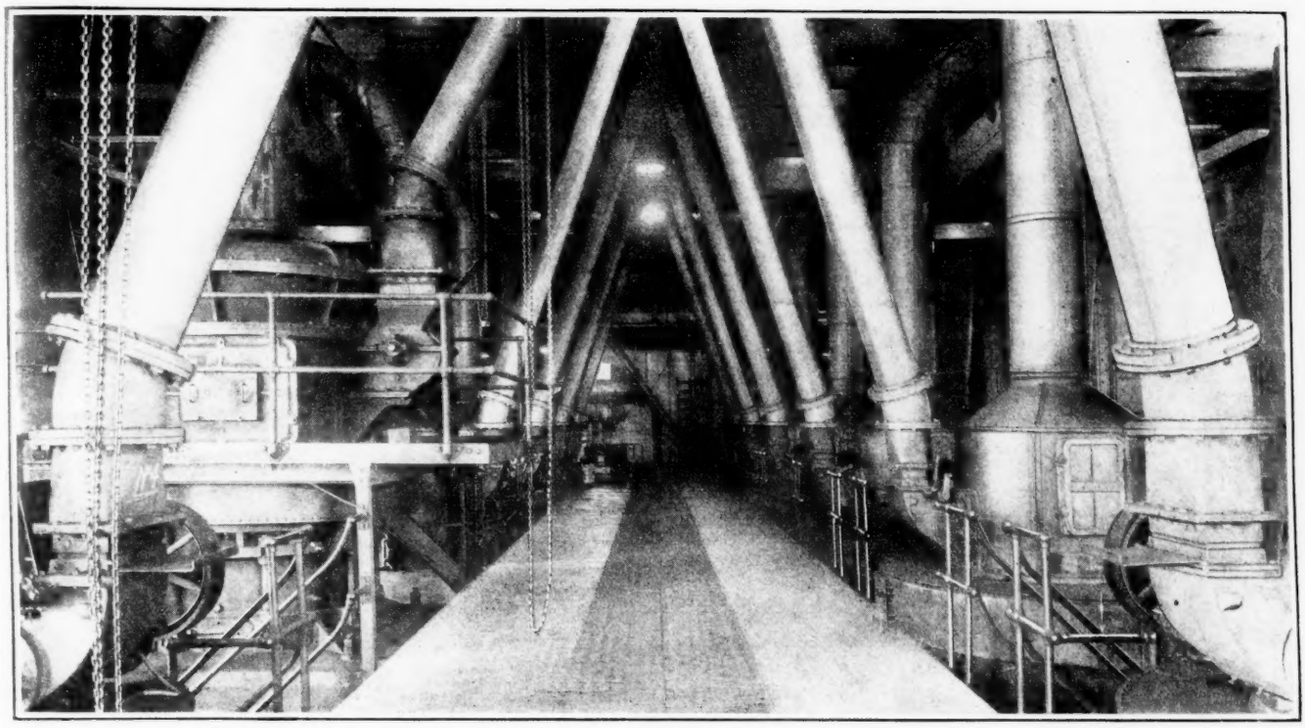


Fig. 6—Looking down the aisle of the mill room

the drier exhauster fan started about thirty minutes before starting the mill. To give the mills dry coal during their operation and to prevent leaving hot coal in the driers, the steam is shut off about thirty minutes before shutting down.

The drier steam is extracted from the house generator turbines at a pressure of about 10 lb. gage. In short, the driers, so far as steam is concerned, are part of the building heating system.

On the ground floor of the mill house are two lines of seven mills, Fig. 6, each mill being fed by gravity

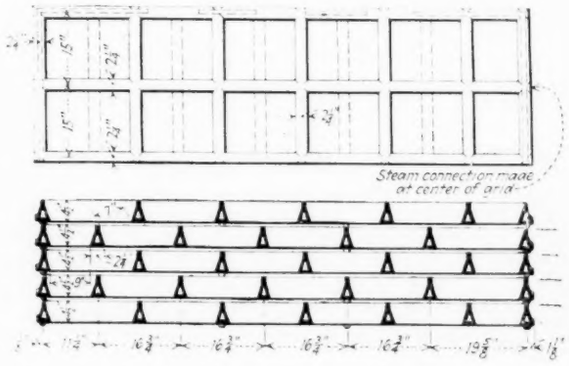


Fig. 7—Heating grid for steam drier

through a pipe from an individual drier. Thirteen of the mills are of the roller type and one of the ball type, each having a capacity of six tons an hour. On a balcony around the mill floor are the mill exhauster fans, and on the floor above are the cyclone separators, screw conveyors and driers. Each pulverizing unit consists of a mill, exhauster fan and cyclone separator, together with the necessary piping. The cyclone separators discharge to either of two pairs of screw conveyors that deliver pulverized coal to a hopper over the Fuller-Kinyon coal pumps. Vents from the mill piping at the cyclone separators are led into the drier duct before mentioned, instead of being discharged through the roof, as formerly. This venting of the mills into the drier duct has eliminated the nuisance of dust from this source, and also the necessity for cleaning out the gooseneck or turn that originally was in the vent piping. It was found that the vent piping to the duct had to make a straight run; otherwise it would plug with damp coal at the bend.

Coal is fed to the mills, in most cases, under the control of an automatic feeder that maintains substantially constant load on the mill, and keeps it working at its best capacity. This promotes the uniformity of pulverization so important to proper combustion of the fuel.

Portions of the connecting piping and casing of the roller type mills were found to be wearing thin after a year or more of operation, and are being replaced, as the mills are overhauled, by a material of greater thickness.

New Fuel for Motor Trucks

During the war those countries having no domestic supplies of gasoline were hard put to secure fuel for the motor transport service. This, together with the disinclination to purchase such vital necessities abroad, has led French engineers to experiment with materials from a local source.

One fuel developed during the current year is "Carbonite," which is composed of charcoal and a secret binder. Waste wood, bark and other forest scrap can be used to produce the charcoal.

In a recent test a Mack truck weighing 5 tons and carrying a 7-ton load made 100 miles on a consumption of 84 lb. of "Carbonite." The ordinary gasoline engine is used without alteration and draws in the charge of gas resulting from the distillation of the charcoal. The producer is no larger than the average gasoline tank and requires but little attention.

Using Standard Transformers to Improve Voltage Regulation

By F. W. SAWYER

SHOWS how five to ten per cent adjustment in line voltage may be obtained with standard transformers. Operating features that must be kept in mind when using transformers in this way are also considered.

AT THE load end of long distribution lines and at other points in the system the voltage is likely to be low owing to the losses in the line. Two of the recognized ways of correcting this trouble are by using voltage regulators and by increasing the size of the conductors. In other cases a power service may be required that is 5 or 10 per cent higher than that supplied by the line, in order to insure a more efficient operation of the equipment.

Induction motors are sensitive to voltage changes in that their torque varies as the square of the voltage. Where torque requirements are severe, it may be desirable to have the voltage above normal rather than below. In such cases and where a small increase in voltage is desirable and standard regulators or other corrective means are not readily available, distribution transformers may be used in the emergency.

Common Emergency Connections

One of the most common emergency connections is shown in Fig. 1. In this figure it is assumed that the voltage at the end of the line is 2,100 and it is desired to raise it to near 2,300. A distribution transformer having a high-voltage winding designed for 2,200 or 2,300 volts may be used for the purpose. Temporarily, the size of the transformer does not make much difference as long as it is large enough to take care of the load. The high-voltage winding is connected across the line and the low-voltage in series. Assuming an instantaneous flow of current as shown by the arrowheads, the low-voltage winding has a voltage induced in it in the same direction as the line voltage. In other words, the two voltages are in series and in a direction so that one adds to the other. If the ratio of transformation is 10 to 1, then the line voltage will be increased by 2,100 ÷ 10 = 210 volts or to 2,100 + 210 = 2,310 volts.

With 2,100 volts on the line a transformer connection like that in Fig. 2 can be used to obtain approximately 2,200 volts. In this case the two sections of the low-voltage winding are connected in parallel, which produces 105 volts, and this added to the line volts gives 2,100 + 105 = 2,205 at the load.

Instead of using the transformer to boost the voltage, it may be applied to produce a reduction, as in Figs. 3 and 4. In these figures the low-voltage winding is assumed to be connected so that the voltage generated in it opposes that of the line, consequently subtracts from the line pressure. The connection shown in Fig. 3 gives a reduction on a 2,400-volt line, with a transformer having a ratio of 10 to 1 of 240 volts, which reduced the line volts to 2,160. This pressure could be used as a substitute for 2,200 volts. Connecting the two sections of the low-potential winding in parallel, as in Fig. 4, gives a reduction on a 2,400-volt line of 120 volts, or to 2,280, which is approximately 2,300.

Increasing the Transformer's Effect

About 1 per cent higher boost or reduction in voltage can be obtained with the connections shown in Figs. 5 to 8, than with those in Figs. 1 to 4. In these figures the high-voltage winding is connected so that it is affected by the change in the voltage and is sometimes referred to as an augmented connection. To understand what voltage is obtained with the connection Fig. 5, first neglect the boosting action. In this case the voltage would be 2,100 on the load side as on the supply side of the transformer, which would be applied across the high-voltage winding. With a ratio of 10 to 1 a voltage of 210 will be developed in the low-voltage winding. This will be reflected on the high-voltage winding and at a ratio of 10 to 1 will increase the potential on the low-voltage winding 21 volts. An increase of 21 volts will therefore result at the high-voltage terminals, which at a ratio of 10 to 1 increases the low voltage 2.1 volts. This process might be carried out indefinitely, but the gain in voltage would become so small as to be negligible.

Value of the Voltage Change

From the process of reasoning there were three increases in the voltage; 210, 21 and 2.1, or a total of, say, 233 volts. This added to the supply volts gives a total potential at the load of 2,100 + 233 = 2,333 volts. At a ratio of 10 to 1 in the transformer the low-voltage winding will have 233 volts induced in it, which checks with the value by the previous course of reasoning. Designating the voltage on the supply side of the transformer as E_p, on the load side as E_s and the ratio as R, then the voltage on the load side may be found by the formula, $E_s = \frac{E_p R}{R-1} = \frac{2{,}100 \times 10}{10-1} = 2{,}333$ volts, as previously obtained.

With the connection Fig. 1 on a 10 to 1 ratio transformer the per cent increase in voltage is (210 ÷ 2,100) × 100 = 10. Using the augmented connection shown in Fig. 5 gives an increase of (233 ÷ 2,100) × 100 = 11.1 per cent.

If the two sections of the low-voltage winding are connected in parallel, as in Fig. 6, they will only be approximately one-half as effective in boosting the voltage as when they are connected in series. Connecting the sections of the low-voltage winding in parallel changes the ratio of the transformer to 20:1, and by applying to Fig. 6 the same course of reasoning that was applied to Fig. 5, it will be found that the load

voltage will be boosted to 2,210 volts, or an increase of $(110 \div 2{,}100) \times 100 = 5.3$ per cent approximately. With the connection Fig. 2 a 5 per cent increase was obtained. By using the formula for the voltage on the load side of the transformer in Fig. 6, $E_s = \frac{2{,}100 \times 20}{20 - 1} = 2{,}210$ volts, which checks with the previous figure.

A higher voltage is obtained with the connections Fig. 7 than with those in Fig. 3. In Fig. 7 the high-voltage winding of the transformer is connected to the line after the voltage has been decreased; consequently, the voltage induced in the low-voltage winding, Fig. 7, will be less than in Fig. 3. By a course of reasoning similar to that applied to Fig. 5, it can be shown that the low-voltage winding will have 218 volts induced in it. This voltage opposes that of the line and reduces the load volts to 2,400 — 218 = 2,182. With a transformer ratio of 10:1 and 2,182 volts impress on the high side of the transformer, the low side will have 218 volts induced in it. This gives a voltage reduction in the system of $(218 \div 2{,}400) \times 100 = 9.1$ per cent. The voltage on the load side of the transformer can be obtained by the formula, $E_s = \frac{E_p R}{(R + 1)} = \frac{2{,}400 \times 10}{10 + 1} = 2{,}182$ volts.

With a transformer ratio of 20:1, as in Fig. 8, the load voltage is reduced to 2,286, when the line voltage is 2,400. This is 6 volts higher than in Fig. 4, for the same reason that a higher voltage is obtained in Fig. 7 than in Fig. 3. The voltage shown in Fig. 8 has been decreased 114 volts, or $(114 \div 2{,}400) \times 100 = 4.75$ per cent. This voltage can be checked with the formula used with Fig. 7, thus, $E_s = \frac{2{,}400 \times 20}{20 + 1} = 2{,}286$.

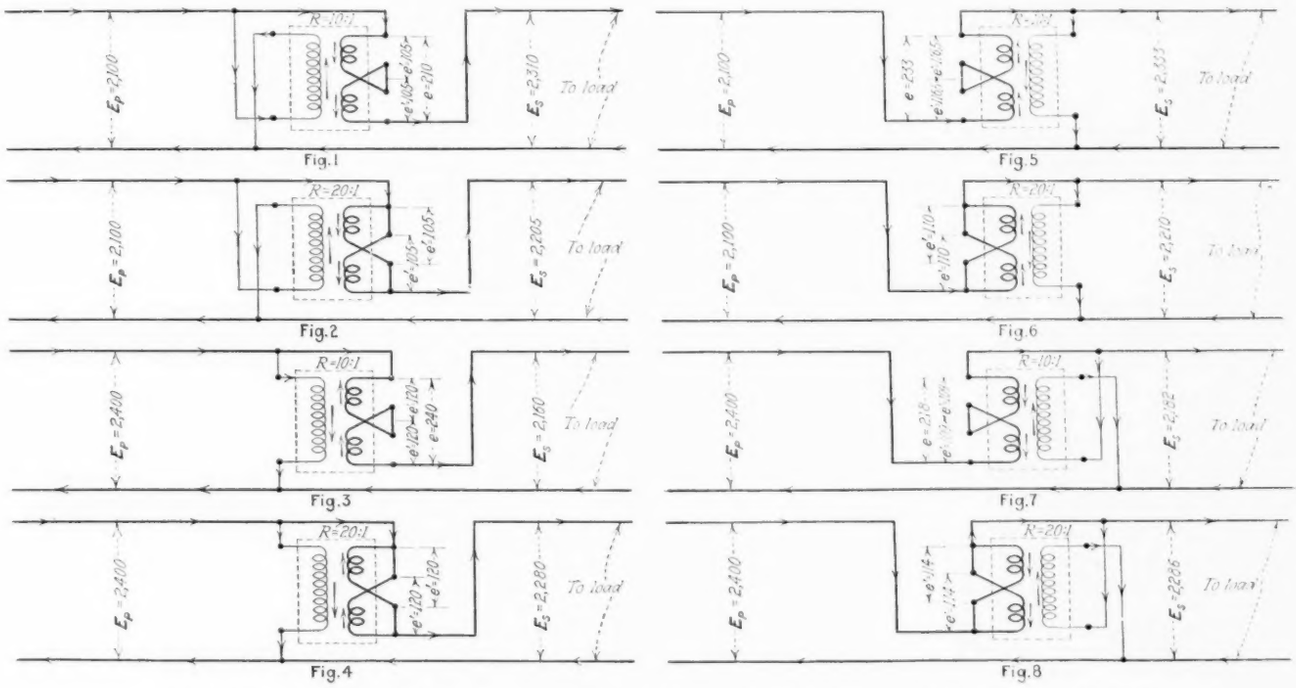
When making these connections, the polarity of the transformers must be kept in mind. However, this is not a serious matter, since after the connections are made, if the voltage does not change in the desired direction, it is only a matter of crossing the connections on one side of the transformers.

Another feature that must be considered is the rating of the transformer. It must have a current capacity in the low-voltage winding equal to the maximum current flowing in the line. The kilovolt-ampere rating of such a transformer may be obtained by the formula,

$$Kva. = \frac{Kw. \times e}{E \times P.F.}$$

where

$Kw.$ = The connected load in kilowatts;
e = The increase or decrease in line volts;



Figs. 1 to 8—Transformer connections for increasing and decreasing the line voltage

Fig. 1 will give a 10 per cent voltage increase; Fig. 2, a 5 per cent increase; Fig. 3, a 10 per cent reduction; Fig. 4, a 5 per cent reduction; Fig. 5, a 11.1 per cent increase; Fig. 6, a 5.3 per cent increase; Fig. 7, a 9.1 per cent reduction; and Fig. 10, a 4.75 per cent reduction. These changes in voltage are obtained with standard transformers.

E = The voltage on the load side of the transformer;
$P.F.$ = The power factor of the load.

As an example assume that in Fig. 1 the load served is 65 kw. at a power factor of 0.70. The voltage on the load side of the transformer is 2,310, which is an increase of 210 volts. Then the rating of the transformer should be

$$Kva. = \frac{65 \times 210}{2{,}310 \times 0.70} = 8.5 \text{ kilovolt-amperes.}$$

To take care of this load, a standard 10-kva. transformer would be required.

When connecting transformers as in the figures, no fuses should be used, since opening the high-voltage winding will cause the low-voltage winding to act as a choke coil in the circuit. As long as the two windings are in circuit, the current in one is in opposition to that in the other and the magnetic flux in the core is held at practically a constant value, and consequently the voltage in the windings remains practically constant. If the high-voltage winding is open-circuited, all the

ampere-turns due to the load current in the low-voltage winding become effective in magnetizing the core. Before the core becomes saturated, the flux may increase to four or five times normal, in which case the voltage will increase in the same proportion. In a 2,300-volt transformer, potentials up to 10,000 or 12,000 volts may be developed. Such a potential would in a short time cause a failure of the transformer's windings.

A fuse in the high-voltage winding will not provide protection to a transformer when connected as shown in the figures. If the transformer were overloaded and the fuse should blow, the decreasing current in the high-voltage winding would allow the ampere-turns of the low-voltage winding to become effective in magnetizing the core and the voltage in the windings would increase, as previously explained. This voltage would probably become so high as to maintain the arc across the fuse, which would not only destroy the fuses and connections, but also damage the transformer.

Since the low-voltage winding is connected to the high, they are both subjected to the same potential. If the transformer is in good condition and the tank is well insulated from the ground, it will suffer no excessive voltage strains. Should the tank become grounded when there is a ground on the high-voltage line, the low-voltage winding will be subjected to the full potential of the line to ground, which is an abnormal condition that should be guarded against.

Although it is possible to obtain lighting voltages off the low-voltage winding, no attempt should be made to do so, since this winding is subjected to the high voltage. Anyone handling such a lamp would be in grave danger of getting a shock at full line voltage to ground, which would probably produce fatal results. Both windings when connected as in the figures, and the case of a transformer, should be treated as high-voltage windings. They should therefore not be touched when the line is alive, unless the necessary precautions are taken for such conditions.

The connections herein discussed should be considered as emergency measures intended to be used temporarily to help out unusual line voltages.

So This Is An Engineer!

The following "want ad" recently appeared in the columns of a well-known New England daily:

> ENGINEER—And Ford repair man; must be thoroughly familiar with oil burning and steam engine; also able to repair Ford trucks and do piping and general repairs around plant; state references and wages in reply.

ONE OF THE METHODS for obtaining hydrogen is through the steam-iron process. Steam at a temperature ranging from 900 to 1,400 deg. F., is passed over iron, resulting in the combination of the iron with the oxygen in the steam to form iron oxide, and the freeing of the hydrogen. In certain high-temperature power plants deposits have been found upon the turbine blading and in the superheater piping. The theory has been advanced that this is an iron oxide, the idea being that while the average steam temperature may be only 700 deg. F., part is high enough to promote the same oxidation and hydrogen freeing followed in the recovery plant.

Measuring Boiler Load Without Flow Meters

BY J. D. JENKINS

THE proper way to determine the load on a boiler is to measure it directly by a flow meter on the feed water or steam. The fact remains that, on one pretext or another, many boilers are not so equipped. What would you do if you were asked to measure the output of such a boiler?

The writer has solved this problem on several occasions by making use of the principle that what comes in minus what goes out must equal what stays. This principle is applied to the dissolved solids in the water entering the boiler. These accumulate in the boiler just as salt accumulates in the Dead Sea. Leaving out of consideration any solids that pass out with moisture in the steam, blowdown is the only path by which they may leave the boiler.

From the analysis of the feed and boiler waters and knowledge of the time the boiler has been on and the quantity of blowdown, the evaporation can be calculated.

For example, take our case of a 6,000-sq.ft. Stirling-type boiler with a volume to normal water level of 5,500 gal. The feed water analyzes 4.5 grains per gallon total alkalinity, expressed as $CaCO_3$. It makes no difference what property of the water is used as a basis of calculation, whether it be alkalinity, total solids, chlorides or sulphates, provided the same property is used throughout the calculation. In our case we used the total alkalinity.

The boiler was blown down four times daily, 3,408 lb. of water each time. At the end of six days and twelve hours run, the boiler water had an alkalinity of 232.5. We had no foaming or priming, carrying uniform superheat. The boiler water was then $232.5 \div 4.5 = 51.7$ times as concentrated as the feed water. In other words, we had fed the boiler, for the 5,520 gal. contained in it at the moment of calculation $51.7 \times 5{,}520$ gal. $\times$ 8 lb. per gal. $= 2{,}280{,}000$ lb. of water. During this period, however, we lost by blowdown, 4 blowdowns $\times$ 3,408 lb. each $= 13{,}630$ lb. per day, which for $6\frac{1}{2}$ days would be 88,600 lb.

We can assume that the average analysis of the boiler water for all the blowdowns from the start of the run, when the boiler was filled with feed water, to the time of calculation was $(4.5 + 232.5) \div 2 = 118.5$ grains per gallon, and that the ratio of evaporation was $118.5 \div 4.5 = 26.3$. The feed water that had been added to produce this concentrated water of blowdown was $26.3 \times 88{,}600$ lb. $= 2{,}330{,}000$ lb. From this we should subtract the water blown down but not evaporated, giving a net evaporation corresponding to blowdown losses of $2{,}330{,}000 - 88{,}600 = 2{,}241{,}400$ lb.

The total evaporation, then, was $2{,}241{,}400 + 2{,}283{,}000 = 4{,}524{,}400$ lb. Per hour this would amount to $4{,}524{,}400 \div (6.5 \text{ days} \times 24 \text{ hours}) = 29{,}000$ lb.

We had an indicating steam-flow meter on this boiler, which during the interval involved, gave an almost continuous reading between 27,000 and 30,000 lb. per hour evaporation. This was a better check than was anticipated.

Taking $8\frac{1}{3}$ lb. of water per gallon, one gallon per minute $= 8\frac{1}{3} \times 60 = 500$ lb. per hour, an easily remembered constant.

The Practical Selection of Oil-Engine Fuels

By EDGAR J. KATES
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THE object of this article is to aid the engineer or owner of an oil-engine plant to select from the various grades of fuel oil on the market, the one that will give the best combination of low price and satisfactory operation.

THE largest item in the operating cost of an oil engine plant is the fuel expense. Consequently, engineers should give serious attention to the problem of obtaining a satisfactory oil at the lowest possible price. Sometimes the lowest-priced oil available is known to be working well in some other plant using the same or similar type of engine. In that case

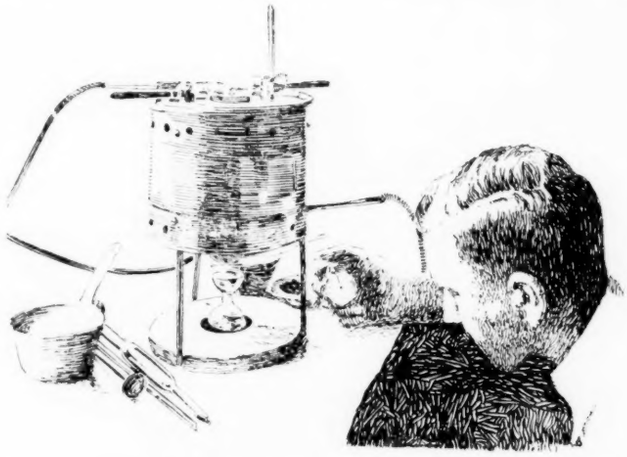


Fig. 1—Finding the viscosity by checking the time taken for 60 c.c. of oil to flow through a calibrated orifice

the choice is easy. In most cases, however, the cheapest oil offered is known to have certain undesirable properties, and the question then arises as to whether one is justified in purchasing higher-priced fuel having better qualities.

The problem would be simplified if it were feasible to set up certain definite specifications and then obtain quotations from various oil companies on fuels meeting these requirements. This procedure is, however, impracticable, and it is usually necessary to obtain quotations from several oil suppliers on their standard grades of fuel oil and then to select the bid that seems to be the best.

Only a few large buyers of fuel oil, such as governmental agencies, are in a position to demand oil that meets a certain specification, and of late years even the specifications of the United States government have been made quite broad and inclusive, so that they can be easily met. In fact, the properties of the fuel oils now on the market are determined not so much by what the purchaser desires as by the necessities of the refineries.

Fuel oil is essentially a residual product; in other words, it is one of the left-overs of the crude oil after the refinery has produced the far more important gasoline. Crude oils come to the refineries from many oil fields and have widely differing characteristics. At one time a refinery's supply may be largely a very heavy crude from the Smackover Field in Arkansas, while a few months later it may be a very light crude from the Garber Field in Oklahoma. The kind of fuel oil produced will vary with the type of crude and with the extent to which the refinery is equipped with cracking apparatus for obtaining gasoline by breaking down some of the oil remaining after the original gasoline content is distilled off.

Though the buyer of fuel oil cannot always insist upon being supplied with oil to meet certain specifications that he may prescribe, nevertheless a knowledge of the important properties of fuel oils will aid him in selecting the best oil for his purposes, out of a number offered to him.

Chemists have devised tests for a great many characteristics of oils, including specific gravity, sulphur, pour

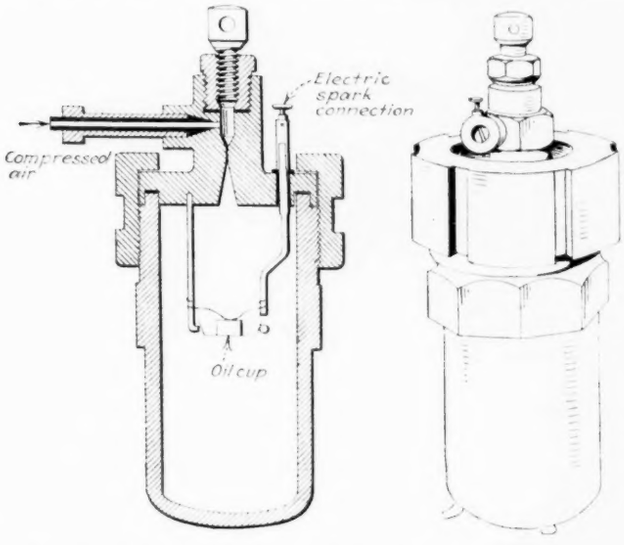


Fig. 2—The heat value is determined by burning a known mass of the oil in a bomb

point, water content, viscosity, color, air distillation, vacuum distillation, ash content, sediment, ignition point, heating value, coke content, hard asphalt, soft asphalt, paraffin content, acidity, elementary composition, flash point and burning point. The oil engine user, in selecting a commercial fuel, need concern himself with but a few important qualities, and these are the ones on which the oil companies can almost always supply full data upon request.

Flash Point—The flash point characteristic is important, but only as a measure of safety in handling the fuel. It is the temperature at which the oil evolves sufficient vapor to ignite momentarily when a small test flame is passed over its surface. This temperature is a rough indicator of the fire hazard, and most insurance

rules and fire ordinances prescribe a flash point of 150 deg. F. or higher, when measured in some form of closed-cup tester. If the flash point meets this requirement, the so-called "burning point" is of little practical significance to the engine user.

Viscosity—Viscosity is determined by noting the time required for a definite quantity of oil under a definite

Fig. 3—Apparatus used in the Conradson coke tester

head to flow through a certain orifice. It is a measure of the fluidity of the oil, and as it varies greatly with temperature, the temperature at which the test was made must always be stated. For instance, an oil having a viscosity of 2,000 sec. Saybolt at 100 deg. F. can be reduced to 100 sec. Saybolt by heating to 200 deg. It is customary to determine the viscosity at 100 deg., but in the case of heavy fuels which may require preheating, the viscosity at 212 deg. should also be ascertained. In Fig. 1 is illustrated a typical Saybolt tester.

The viscosity determines whether the oil will have to be preheated to handle it from the storage tank to the engine, and in the engine fuel pumps and spray valves. High-viscosity oils can be satisfactorily burned in most modern oil engines, but they introduce the operating complication of more or less elaborate preheating systems. Furthermore, viscous oils are more likely to contain water and mechanical impurities in suspension and, therefore, usually require more attention to filtration and settling arrangements. When using viscous oils, it is often necessary to start the engine on a thinner fuel and switch over to the heavier oil after the warming up process has been completed. Likewise, when stopping the engine for more than a few minutes, it is desirable to let it run on thin oil just before shutting down, as otherwise the pumps and piping will contain chilled viscous oil when the time comes to start.

Because of the superior atomizing power of the spray nozzles of air-injection engines, such engines can use a higher viscosity oil without preheating, than can solid-injection engines. To obtain good spray action, solid-injection engines require oil having a viscosity less than 125 sec. Saybolt at the temperature at which it is delivered to the spray nozzles. If this temperature is, say, 100 deg. F., then oils of higher viscosity than 125 sec. Saybolt at 100 deg. F. will want preheating to reduce the viscosity. Most air-injection engines can, without preheating, satisfactorily spray oils up to a viscosity of 200 sec. Saybolt at 100 deg. F.

In certain cases preheating sufficiently to reduce the viscosity to the required amount will cause the oil to bubble and emit vapors, resulting in irregular fuel pump action. This is particularly likely to occur with oils containing a considerable amount of water, and also with some crudes containing a fraction of very light constituents which will be driven off at a fairly low temperature. Such oils will swell to several times their original volume because of the bubbles, and are very troublesome, if not impossible, to use. One engine builder has devised a method of keeping the oil under pressure while it is being preheated, in order to limit the evolution of vapor.

Heat Value—The heat value of an oil does not signify how well it will burn in an engine; oils of low heat content can be used with entire satisfaction provided their other characteristics are favorable. The fuel consumption, however, in terms of pounds of fuel per horsepower-hour, is affected directly by the heat value, and for this reason it is usually specified in the guarantees of engine builders.

The amount of heat energy in the fuel is customarily expressed in the form of B.t.u. per pound. The heat value can be stated in two ways, either the higher (gross) heat value or the lower (net) heat value. This is often a cause of misunderstanding. The higher heat value is that which is determined in a bomb calorimeter, such as shown in Fig. 2, where the products of com-

Fig. 4—Method of finding the specific gravity or the Baumé reading

bustion are reduced to a low temperature, so that the water vapor is condensed. Oils used for fuel contain about 12 per cent of hydrogen, which uniting with oxygen, burns to water vapor, weighing something more than the weight of the oil itself. The laboratory methods of determining heat value condense this water vapor and thus show a higher heat value by recovering the latent heat of the water vapor. On the other hand, when oil is burned in an engine, the products of combustion are always exhausted at a temperature high enough to keep the water in the form of vapor and the latent heat is lost. This reduces the available heat giving the lower or net heat value, which for ordinary fuel oils,

is less than the higher heat value by about 1,150 B.t.u. per pound. Inasmuch as the guarantees of engine manufacturers and the specifications of oil companies state heat values sometimes in one form and sometimes in the other, it is important to keep the distinction in mind and to reduce all to the same basis.

The lower heat values of common fuel oils do not cover a wide range, varying from about 17,000 to 18,500 B.t.u. per pound, though some California and Mexican crudes will show considerably less. Oil is customarily sold by the barrel or gallon and therefore the heat content per unit of volume is of more direct financial significance. It so happens that the oils that have less heat value per pound are the heavier oils, weighing more pounds to the gallon, and consequently the heat energy per gallon is fairly uniform for most commercial oils, being about 135,000 B.t.u. lower heat value.

Water Content—Water, in the small quantities as found in most oils on the market, is undesirable mainly because it reduces the heat energy for which the purchaser is paying. In thin oils the water will rapidly settle out if the oil is undisturbed in the tank, or if the flow in a pipe is slow. On the other hand, viscous oils, particularly some crude oils, will hold water in suspension for long periods, and this water will often occur in the form of slugs. If such masses of water are allowed to reach the engine fuel pumps, irregular combustion or even misfiring will result. The water content of most viscous oils can be removed by preheating and then settling, but there are exceptions where it is practically impossible to remove the water with the facilities available in an ordinary power plant.

If finely subdivided in the oil, water does not interfere with the combustion. In fact, it is quite possible thus to burn oils containing over 20 per cent of water.

Government specifications on fuel oils call for a deduction in quantity for all water plus sediment in excess of 1 per cent.

Sulphur—The sulphur content of an oil burns largely to sulphur dioxide. As long as this is hot, and therefore dry, it has no corrosive effect. For example, sulphur dioxide gas is used as the refrigerating fluid in a common make of household refrigerating machine and gives no trouble from corrosion if free from moisture. However, if the exhaust gases of an engine burning an oil containing sulphur are allowed to cool, either because of the chilling effect of a long exhaust pipe or because the engine is stopped, some of the water vapor that is always present in the exhaust, will condense and will combine with the sulphur dioxide to form sulphuric acid, which of course will attack many metals, especially steel.

Long exhaust pipes should, if possible, be avoided for this as well as for other reasons. If a long line is compulsory, the corrosion of the piping can be prevented by making it of cast iron rather than steel.

Corrosion inside of the engine can be prevented by running the engine, just before stopping it, on a fuel containing little or no sulphur. This will clear the engine and exhaust piping of the destructive agents which would otherwise have an opportuity to act while the engine was cold.

The exhaust gases from a sulphur-bearing oil usually have a penetrating and offensive odor. This may not be objectionable in a plant in the open country, but may become a serious nuisance where dwellings are situated near-by. In such cases the best solution is to change to an oil containing less than $\frac{1}{2}$ per cent of sulphur; such oils can be obtained in many sections. If it is impracticable to change the oil, the sulphur gases can be washed out of the exhaust by water. As this will make the water quite acid, the tanks and piping should be of cast-iron. Some have claimed that the piston deposits of gum were produced by chemical action of the sulphur compounds upon the lubricating oil, causing it to break down into a tarry substance. Others, however, point to the fact that these fuels are not only high in sulphur, but also high in bituminous substances, and they advance the argument that these constituents of the fuel are themselves the source of the troublesome film of gum and tar.

Asphalt—Several methods have been devised for indicating the completeness with which an oil may be expected to burn.

The coke content is obtained by distilling down and heating the oil until it has carbonized and then weighing the coke residue. This is often given under the name of "Conradson Test," the equipment used being shown in Fig. 3.

Hard asphalt is that part of the oil insoluble in light gasoline, and if gasoline be mixed with the oil, the asphalt will settle to the bottom after a short time.

Total asphalt, sometimes incorrectly termed soft asphalt, is that part of the oil insoluble in a mixture of alcohol and ether. This includes both the soft asphalt and the hard asphalt.

There is no direct relationship between these three tests, though the coke value is usually less than the total asphalt. H. Moore, an English chemist, believes the best test to be the hard asphalt, as this shows the harder bituminous substances which will not dissolve in gasoline and which, he believes, are what really cause the troubles in engines. He gives the following table to illustrate why Comodoro Rivadavia, South America, oil burns much better in an engine than Mexican oils of the same total asphalt content.

	Specific Gravity	Conradson Coke Test, Per Cent	Hard Asphalt, Per Cent	Total Asphalt, Per Cent
Heavy Mexican Oil	0.966	12.37	16.43	20.58
Comodoro Rivadavia	0.942	7.38	5.86	23.9

The writer's experience has been that, for practical purposes, oils having a Conradson Coke Test of over 8 per cent or a hard asphalt content of over 12 per cent should be avoided.

Ash—The amount of ash produced when the oil is burned is important only in the case of heavy oils, especially crudes. Common fuel oils seldom produce enough ash to warrant consideration.

However, when the ash content is large, say 0.05 per cent or more, the products of combustion will contain enough grit to cause rapid wear of pistons and liners.

Specific Gravity—Specific gravity is of little direct value to the engine user. It affects the amount of freight he will have to pay on a given number of gallons or barrels of oil, since freight is reckoned on weight. The gravity is ascertained by a hydrometer, as shown in Fig. 4. When the viscosity is not stated, the specific gravity will indicate, in a rough way, the fluidity of the oil and its ease of handling. Oils less than 20 deg. Baumé, corresponding to 0.934 specific gravity and 7.781 lb. per gal., are usually classed as heavy oils.

What Is the Most Economical

Size of Power-Plant Piping?

By FREDERIC C. EVANS*

THE author shows how to figure the size of pipe for a given job to give the minimum total cost per year. For large or long lines this is well worth doing.

THIS article is the result of an attempt to determine in a rational manner the size of the high-pressure power piping in a steam plant. The analysis is based on the principle that there is one size of pipe that is cheapest, all things considered, and this is the proper size to use.

Too small a pipe introduces excessive pressure drops, which reduce the mechanical energy available at the turbine and so increase the coal consumption. Too large a pipe requires an increased investment in pipe and insulation and also increases the loss due to radiation. The best size of pipe balances all these factors to a minimum annual cost.

In order that the principle may be clarified, a numerical problem will be solved as the method of obtaining the proper balance is developed. Suppose that it is desired to find the proper size of steam main to supply a 10,000-kw. turbine generator. The combined engine efficiency of the unit is 75 per cent. Steam is available at the boiler nozzle at a pressure of 200 lb. per sq.in. abs. and a temperature of 600 deg. F. The back pressure on the turbine is 1 in. of mercury abs. The boiler efficiency is 80 per cent when using a coal costing $5 per ton and having a heating value of 12,500 B.t.u. per lb. The pipe line is 200 ft. long, and the effect of the bends, fittings, etc., may be taken care of by considering the line to have an equivalent length of 300 ft. The pipe is to be of the weight specified by the Power Piping Society and is to be insulated with three inches of 85 per cent magnesia.

The Fixed Charges on the Pipe Line

First, assume a pipe size that would be about right, say 10 in. To meet the pressure requirements a pipe of inside diameter of 10.02 in. and weighing 40.48 lb. per ft. is necessary. The cost of this pipe is determined from the curve of Fig. 1, which is more or less arbitrarily assumed to represent the price of pipe and ordinary fittings. Thus, for the 10-in. pipe, the cost per foot is found to be $40.48 \times \$0.199 = \$8.05$. This includes ordinary fittings.

Assuming the 85 per cent magnesia to cost 50 per cent of the list price, the cost of the insulation is $3.65 per foot. This gives a total cost of the pipe, fittings and covering of $11.70 per foot. Labor and maintenance costs may be omitted, since they would be about the same for all sizes of piping that might deserve consideration. Thus the 200 ft. of piping will cost $200 \times \$11.70 = \$2,340$. If the fixed charges are taken as 15 per cent, the annual cost of the piping and insulation will be $0.15 \times \$2,340 = \$351$.

The Annual Cost of the Pressure Drop in the Pipe Line

Considering that the turbine operates without bleeding or reheating, the available energy at the turbine, assuming no throttling in the pipe line, is the adiabatic heat drop from boiler conditions to the back pressure, which is, using the notation defined in Fig. 2,

$$h_a - h_b = 1,316.8 - 898 = 418.8 \text{ } B.t.u. \text{ } per \text{ } lb.$$

where

h_a = The heat content of the steam leaving the boiler;

h_b = The heat content of the steam at condenser pressure and the same entropy, at the end of the ideal adiabatic expansion.

Actualiy, with no throttling, since the combined engine efficiency is 75 per cent, the energy available

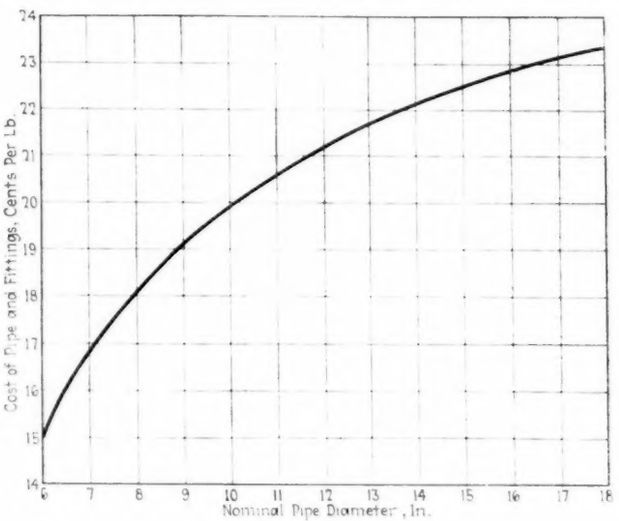


Fig. 1—Assumed schedule of prices for pipe and ordinary fittings

at the generator leads per pound of steam is $0.75 \times 418.8 = 314$ B.t.u. If there were no throttling, the weight of steam required per minute, at the rated load of 10,000 kw., would be $\frac{3,413}{314} \times \frac{10,000}{60} = 1,810$ lb., and, since the specific volume of the steam leaving the boiler is 3.1 cu.ft. per lb., the volume per minute would be $1,810 \times 3.1 = 5,610$ cu.ft.

*Assistant professor of heat power engineering, Cornell University.

Since the pipe has an inside diameter of 10.02 in., the corresponding velocity would be

$$\frac{cu.ft.\,per\,min.}{sq.ft.} = \frac{5{,}610 \times 4 \times 144}{\pi \times 10.02 \times 10.02} = 10{,}250\ ft.\ per\ min.$$

The small amount of throttling that the chosen pipe size will cause will not modify the velocity appreciably,

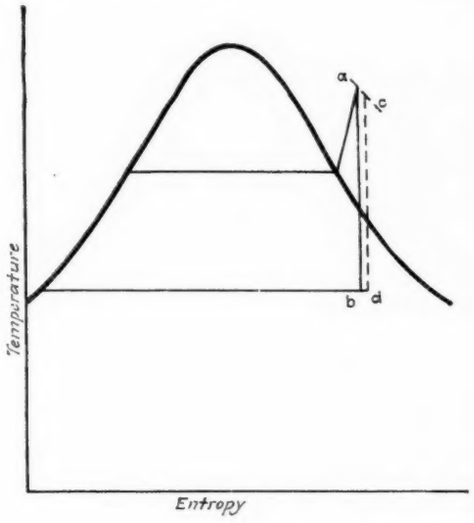


Fig. 2—Diagram showing ideal expansion with and without throttling

so this value may, for all practical purposes, be considered to be the actual velocity of the steam flowing within the pipe.

Formula for Figuring Pressure Drop

The pressure drop in the pipe line may be difficult to predetermine owing to the lack of information on the subject, particularly if high pressures are involved. B. N. Broido, in an article entitled "High-Temperature and High-Pressure Steam Lines" ("Transactions A.S.M.E.," Vol. 56, Dec. 12, 1922, page 913) recommends Fritsche's coefficients applied to the usual pressure-drop equation for pipe lines carrying superheated steam. The drop in pressure, according to this authority, is given by the equation

$$p' = \frac{cv^2L}{Vd}\ lb.\ per\ sq.in.$$

where

p' = The drop in pressure;
c = Fritsche's coefficient

$$= 0.0000022 \left(\frac{R}{144}\right)^{0.148} \left(\frac{T}{pv}\right)^{0.148} d^{0.202};$$

v = The velocity of the steam in feet per second;
L = The equivalent length of the piping in feet;
V = The specific volume of the steam in cubic feet per pound;
d = The diameter of the pipe in feet;
R = 85.7 for steam;
T = The absolute temperature of the steam in degrees F.;
p = The average pressure in the line in pounds per square inch abs.

For the case under consideration, the coefficient

$$c = 0.0000022 \left(\frac{85.7}{144}\right)^{0.148} \left(\frac{1{,}060 \times 60}{200 \times 10{,}250}\right)^{0.148} \left(\frac{10.02}{12}\right)^{0.202}$$
$$= 1.28 \times 10^{-6}$$

and

$$p' = \frac{1.28 \times 10^{-6} \times \left(\frac{10{,}250}{60}\right)^2 \times 300}{3.1 \times \left(\frac{10.02}{12}\right)} = 4.35\ lb.\ per\ sq.in.$$

The pressure at the throttle of the turbine is, then, 200 — 4.35 = 195.65 lb. per sq.in. abs.

The effect of this pressure drop is shown in Fig. 2, since $p' = p_a - p_c$, state c being the condition of the steam at the end of the pipe line. Neglecting radiation, which is necessarily small, $h_a = h_c$, because frictional throttling is a process during which the heat content is unchanged. However, the turbine suffers from the drop in pressure because the mechanical energy available from the turbine is reduced to $h_c - h_d$. The loss of available energy due to the throttling in the pipe line is

$$T_b(\phi_c - \phi_a)\ B.t.u.\ per\ lb.$$

where

T_b = The absolute temperature of the exhaust steam in degrees F.;
ϕ_c = The specific entropy of the steam after throttling;
ϕ_a = The specific entropy of the steam before throttling.

In order that this equation be accurately solved, the difference in entropy must be accurateley determined. Fig. 3 has been drawn to permit this determination This is an enlarged view of a constant heat-content line (equal to the heat content at the boiler nozzle) plotted on entropy-pressure co-ordinates, permitting the gain in entropy resulting from any reasonable pressure drop

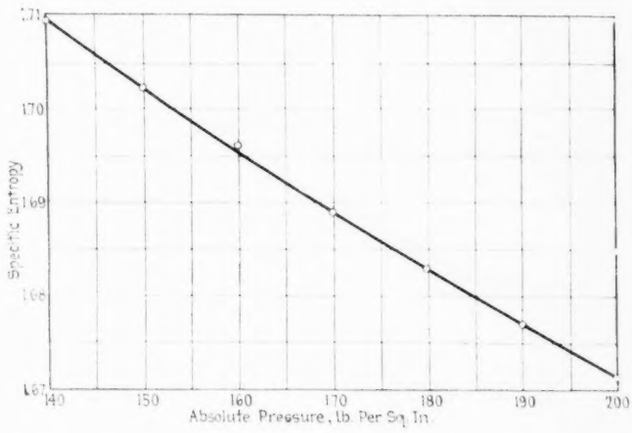


Fig. 3—Variation of entropy with pressure for constant heat content throttling from the assumed initial conditions

due to throttling to be determined. For the case in point, the resultant loss of available energy is

$$(79.2 + 460)(1.6739 - 1.6715)$$
$$= 1.29\ B.t.u.\ per\ lb.\ of\ steam.$$

The per cent loss of available energy is very closely equal to the per cent additional steam required. Thus, the per cent additional steam required due to the throttling in the pipe line is $\frac{1.29 \times 100}{418.8} = 0.31$ of one per cent.

This additional steam necessitates additional coal and, fundamentally, this additional fuel cost is the disadvantage of the pressure drop in the line. The heat supplied each pound of steam in the boiler is, referring to Fig. 2,

$$h_a - h_{t_b} = 1{,}316.8 - 47 = 1{,}269.8\ B.t.u.$$

where h_{f_b} = the heat content of the liquid at the exhaust pressure.

With 80 per cent boiler efficiency the heat supplied from the coal per pound of steam is $\frac{1,269.8}{0.8} = 1,588$ *B.t.u.*

With no throttling, since 1,810 lb. of steam is required per minute when running at the rated load, the tons of coal per hour are

$$\frac{1,810 \times 1,588 \times 60}{12,500 \times 2,240} = 6.15$$

If the unit runs continuously at the rated load, the tons of coal per year, if there is no loss due to throttling or radiation, amount to $6.15 \times 24 \times 365 = 53,900$.

With the pipe line supplying steam to the main unit when it is operating continuously at the rated load, the additional coal required per year to overcome the

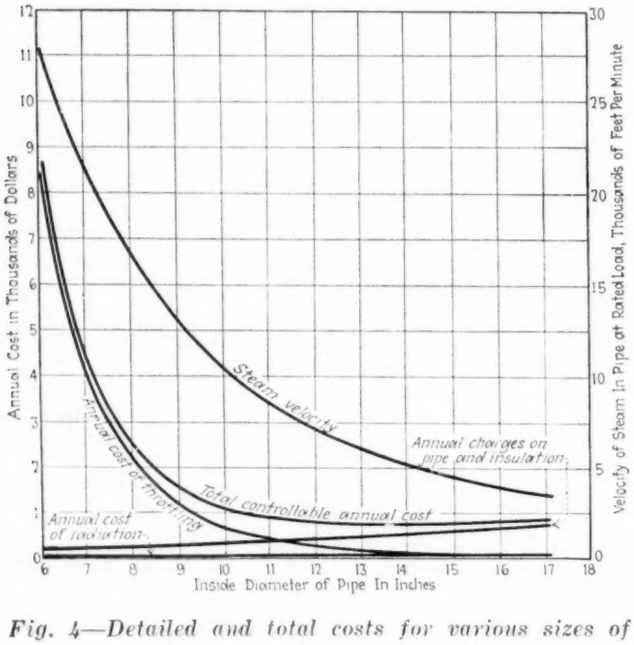

Annual Cost in Thousands of Dollars
Velocity of Steam In Pipe at Rated Load, Thousands of Feet Per Minute
Inside Diameter of Pipe In Inches
Steam velocity
Annual charges on pipe and insulation
Annual cost of throttling
Total controllable annual cost
Annual cost of radiation

Fig. 4—Detailed and total costs for various sizes of pipe, in service 75 per cent of the time

loss due to throttling amounts to $53,900 \times 0.0031 = 167$ tons. The annual cost chargeable to throttling is, then, $\$5 \times 167 = \$835$. Unlike the fixed charges on the initial installation, this cost will be directly proportional to the time during which the pipe line is transmitting steam.

The foregoing calculations assume that the turbine is running at rated load whenever it is in service. If this is too far from the truth, the average turbine load rather than the rated could be used in determining this cost.

Annual Cost of Radiation from Pipe Line

The third factor that may be taken into account is the radiation loss. In this case, with the same steam temperature and the same insulation the larger the pipe the greater the magnitude of this loss.

A method of calculating this loss is given by W. A. Carter and E. T. Cope[1]. As a result of Heilman's work at the Mellon Institute of Industrial Research, a formula is developed for the loss of heat from the canvas surface of an insulated pipe. This formula is

$$h_1 = \frac{147.6 D^{0.81} (t_c - t_a)}{272.5 - (t_c - t_a)}$$

where

h_1 = The loss per hour per linear foot of pipe in B.t.u.;

D = The diameter of the canvas surface in inches;

t_c = The temperature of the canvas surface in deg. F.;

t_a = The temperature of the surrounding air in deg. F.

Another formula is also given for the rate at which heat passes through the layer of pipe covering. This formula, for a single composition covering, is

$$h_2 = \frac{0.524 K (t_p - t_c)}{\log_e \frac{r_c}{r_p}}$$

where

h_2 = The B.t.u. flowing through covering per hour per linear foot of pipe;

K = The heat-transmission coefficient in B.t.u. per square foot per hour per inch of thickness per degree F. temperature difference between the hot and cold surfaces;

t_p = The temperature of the inside surface of the insulation in degrees F., which may be taken as the steam temperature;

t_c = The temperature of the outside surface of the layer of pipe covering in degrees F.;

r_c = The radius in inches of the outside surface of the pipe covering;

r_p = The radius in inches of the inside surface of the pipe covering, or radius of the outside of the pipe.

It is obvious from the equations that h_1 must equal h_2 and the determination of the radiation loss involves finding the value of t_c that will make this true. Assuming $t_a = 80$ deg. F., $K = 0.3$ and knowing that $D = 16.75$ in., $r_c = 8.376$ in., and $r_p = 5.375$ in., and following the method of Carter and Cope, it is found that $h_1 = h_2 = 174$ B.t.u. per hour per linear foot.

The radiation loss in the complete line per hour must be, then, $200 \times 174 = 34,800$ B.t.u.

If the pipe line is in use continuously, the additional coal required per year to offset this radiation is

$$\frac{34,800 \times 24 \times 365}{12,500 \times 2,240 \times 0.8} = 13.6 \text{ tons}$$

The annual cost of radiation, then, is $13.6 \times \$5 = \$68$. As in the case of the loss due to throttling, this loss varies directly with the proportion of the time during which the pipe line is transmitting steam, assuming that the line is shut off when the unit is not taking steam.

Summary of the Results

The *controllable annual cost of the pipe line* is the fixed charges on the pipe and insulation plus the annual cost of the pressure drop plus the annual cost of radiation.

In this article the best pipe size is taken as the one having the minimum controllable annual cost. To determine this size, this same calculation can be made for other pipe sizes, say 6-in., 14-in., and 18-in. nominal. The results, with continuous use of the pipe, are shown in the first part of the table. The last part of this table shows the annual cost of the pressure drop and the radiation reduced in proportion to the pipe use factor, thus obtaining the annual controllable cost at reduced use factors.

[1] "The Rational Design of Covering for Pipes Carrying Steam up to 800 Deg. F., *Mechanical Engineering*, October, 1925.

Fig. 4 is a plot of the results shown in the table for the use of the pipe 75 per cent of the time. There is a distinct low point in the total controllable annual cost curve, indicating that the 14-in. pipe is the most economical at this use factor. This corresponds to a steam velocity of 5,850 ft. per min. This is certainly conservative when compared with common, present-day practice. It is also obvious that this curve is so flat in this region that a 10-in. pipe having a steam velocity of 10,250 ft. per min. or a 12-in. pipe would be only slightly less economical. Other factors, such as the reduced difficulty of finding a place for the smaller piping and fittings in the plant, greater ease of handling, etc., might outweigh this slight loss of economy and justify the smaller pipe. However, in power piping

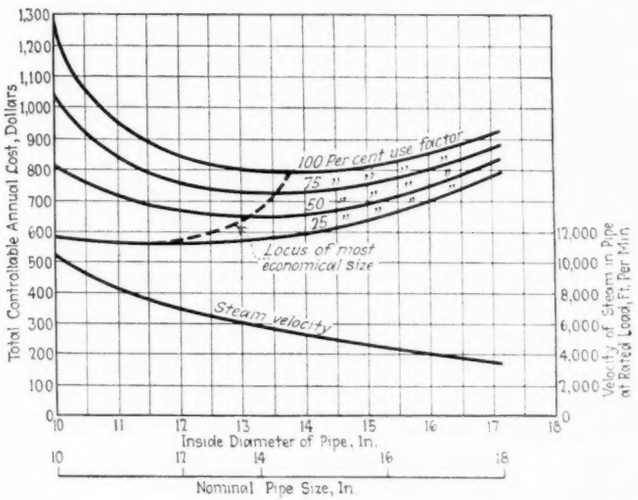


Fig. 5—With lower use factor, smaller pipe is justified

this reduction in size should not be extended too far, as the cost of the pressure drop increases very rapidly. It is to illustrate this that the extreme case of a 6-in. pipe is included.

TABLE I—ANNUAL COSTS OF PIPING

Nominal pipe size, in	6	10	14	18
Actual inside diameter, in	6.065	10.02	13.25	17.125
Weight per foot lb	18.97	40.48	54.57	82.06
Velocity at rated load with no throttling ft. per min	27,900	10,250	5,850	3,500
Pipe in Use 100 per Cent of the Time				
Fixed charges on pipe and insulation, dollars	166	351	500	744
Annual cost of pressure drop, dollars	11,240	834	215	81
Annual cost of radiation, dollars	48	68	80	105
Total annual controllable cost, dollars	11,454	1,253	795	930
Pipe in Use 75 per Cent of the Time				
Fixed charges on pipe and insulation, dollars	166	351	500	744
Annual cost of pressure drop, dollars	8,445	625	162	60
Annual cost of radiation, dollars	36	52	60	79
Total annual controllable cost, dollars	8,647	1,028	722	883
Pipe in Use 50 per Cent of the Time				
Fixed charges on pipe and insulation, dollars	166	351	500	744
Annual cost of pressure drop, dollars	5,620	417	108	40
Annual cost of radiation, dollars	24	34	40	53
Total annual controllable cost, dollars	5,810	802	648	837
Pipe in Use 25 per Cent of the Time				
Fixed charges on pipe and insulation, dollars	166	351	500	744
Annual cost of pressure drop, dollars	2,810	209	54	20
Annual cost of radiation, dollars	12	17	20	26
Total annual controllable cost, dollars	2,988	577	574	790

Fig. 5 is drawn from the data of the table to illustrate the effect of the pipe use factor on the most economical pipe size. It is obvious that, with a lower use factor, a somewhat smaller pipe is justified. The 6-in. case is not included in this figure because, unless the use factor is very low, a 10-in. pipe is the smallest size that deserves consideration.

Some readers may disagree with the costs quoted, for these are difficult to obtain accurately. This, however, does not affect the method of making the calculation, but merely the numerical results.

It is possible to extend the analysis as may seem justified. Such additional factors as different thicknesses of insulation for the different pipe sizes, effect of anticipated load on cost of throttling, etc., may be included. However, the resultant cost curve is so flat that great refinements are probably unnecessary.

Some "Chain" Don'ts

By David Fliegelman

In order to insure the long life and satisfactory service of chains, they must be handled properly. To help attain this end the following "don'ts" are recommended:

1. Use a chain unless it has already been tested and carefully inspected.
2. Overload a chain above its rated safe-load capacity.
3. Use a chain that shows excessive wear, or that has been stretched by overloading, or that shows deformed links, poor welds or any other physical defects.
4. Apply load suddenly.
5. Twist the chain.
6. Bend the links around sharp corners or edges.
7. Force hooks into place by hammering.
8. Spread the legs of double-sling chains any more than is absolutely necessary.
9. Put an unequal load on one leg of a sling.
10. Take chances.

Chains should be kept clean and free from grit. Oiling chains prevents them from rusting. The hooks and rings, as well as the chains, should be given frequent inspection.

A Vacuum Tube which produces as many electrons per second as a ton of radium—and there is only a pound of that rare substance in the world—was recently announced by Dr. W. D. Coolidge, of the research laboratory of the General Electric Company. So concentrated are the rays from the tube that many startling experiments have been conducted with the new device. Crystals of the mineral calcite apparently become red-hot coals when exposed for a moment to the rays, but they are glowing with cold light; ordinary salt is turned brown, and considerable time elapses before it again becomes the colorless substance it usually is; bacteria and small flies are almost instantly killed by exposure to the rays; ordinarily colorless acetylene gas is transformed into a yellow solid which cannot be dissolved; and a rabbit's gray hair has been destroyed, to be replaced later by a profuse growth of longer, snow-white hair.

Although the Jaw Type of coupling often used to connect the shafts of a turbine and a generator is known as a "flexible coupling," the flexible feature should not be overestimated. Successful operation requires that every precaution be taken to insure that accurate alignment of the shafts is maintained. The flexible feature is mainly the permitting of axial movement of the two shafts with changes in temperature.

Power Plant Moved Without a Shutdown

Kern Packing Plant in New York City Moved Several Blocks Without Ceasing Operation—Power Plant Supplies Power, Heat and Refrigeration.

RELOCATION of a factory is by no means unusual, and frequently this entails the shifting of the power-plant machinery. Seldom, though, is the plant kept in operation during the removal, as was the case when the Kern meat packing plant in New York City was moved several blocks.

The Kern Packing Co. occupied a building on Thirty-eighth Street adjoining the Kern Building occupied by a number of printing concerns. In the basement of the latter building was the power plant which supplied light, power and heat to the printing companies and to the meat packing house. The machines included three horizontal water-tube boilers, a Corliss-engine-driven ammonia compressor, a motor-driven compressor and four uniflow engines driving direct-current generators. Three of these engines were horizontal and were among the first uniflows built by the Ames Iron Works Co. The fourth was of the four-cylinder vertical design, as shown in Fig. 1, being the first vertical uniflow put out by their shops.

The power load was such that the engines supplied all the low-pressure steam needed in the meat cooking,

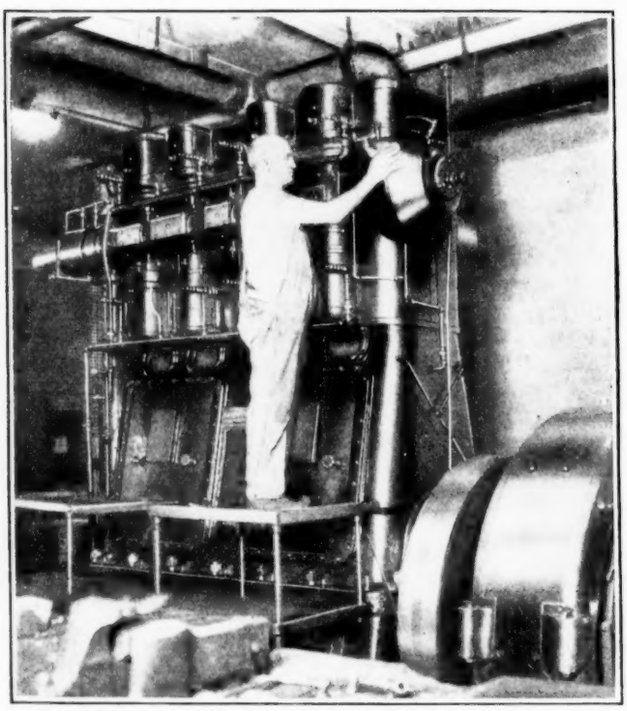


Fig. 1—The vertical uniflow in the old plant where floor space was at a premium

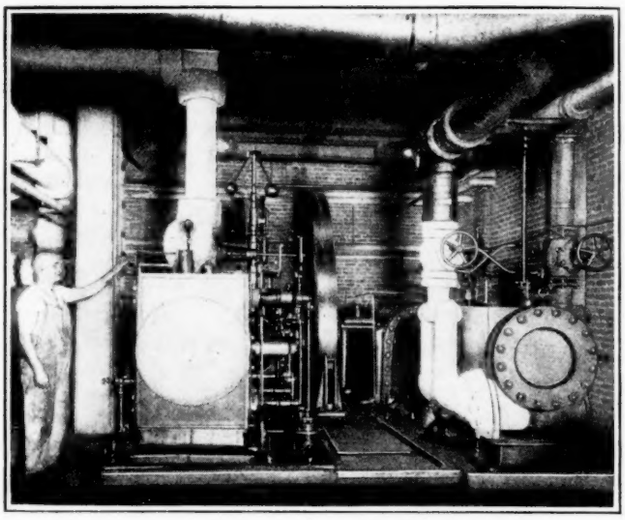


Fig. 2—The ammonia compressor is operated without a water jacket

and during the winter, that required by the building heating system. The operating costs, as a consequence, were very low if the power plant be credited with the value of the exhaust steam supplied to the several departments. Even without such credits the operating costs per kilowatt-hour were less than 1½c., the cost per ton of refrigeration was 75c., and a ton of ice was produced at a power cost of $1.40.

City zoning laws restrict the slaughtering of hogs in any save a few blocks adjacent to the Hudson River, between Thirty-ninth and Forty-first Streets, and the Kern Co. was forced to purchase the carcasses. The company desired to extend its packing activities and so decided to erect a new building at Eleventh Avenue and Fortieth Street. The low generating costs at the old plant, together with the large demand for cooking steam, indicated the desirability of generating power on the premises.

Purchased Power in the Printing Plant

With the abandonment of the former packing house the power load of the printing shops in the Kern building did not justify the maintenance of the power plant in the basement, and purchased power appeared to be the cheaper. This was especially true since electricity could be purchased at wholesale rates from the public utility and retailed to the printing firms at a definite profit.

Heating during the winter months will be by live steam from two of the old boilers, and for summer hot-water service a new and smaller boiler was installed in place of the third old boiler, which was junked.

As it was impossible to discontinue the meat packing during the transfer without inconveniencing customers, the management decided to plan the shifting of the equipment in such a manner as to permit operation without interference with the output.

When the power-plant machinery was studied, it was found that the refrigerating demand required the continued operation of the 125-ton Corliss compressor, and to provide ample refrigerating capacity at the new plant without waiting for this machine, a used hori-

zontal Corliss-driven compressor was purchased from a New York brewery. This, shown in Fig. 2, was installed before any of the other machinery was moved from the Kern Building.

Since the old boilers were to be left for heating purposes, three Kingsford water-tube units were installed in the new plant. They are in the basement on the side fronting Fortieth Street, with the coal bin under the sidewalk. Hand firing will be followed, as the chief engineer feels that for the loads to be carried, an intelligent fireman can obtain results as economical as those reached by mechanical firing. Unfortunately, the available space is such that the fireroom will be decidedly uncomfortable in summer.

As soon as the boilers were installed, the piping was put in according to the plans of the chief engineer; Van Stone joints with fiber gaskets are used. By reason of the interruptions the pipefitters might be subjected to, it was decided that a cost-plus contract for the piping would be the most equitable for both the contractor and the packing house.

The first step taken was to install the purchased ice machine, followed immediately by the moving and installation of one of the 75-kw. uniflow units. As soon as these were in operation, the new packing house started handling the curing of hams, etc. The next move was the installation of the 150-kw. set, and in a short time the 350-kw. vertical uniflow unit was installed in the new plant. The second 75-kw. uniflow was sold.

The entire packing activities at the old plant now ceased, and the motor-driven ice machine was shifted to the new site and will be used as a stand-by.

The packing house uses about 8,000 gal. of water per hour, and all this is passed through the double-pipe ammonia condenser on the roof, discharging into a service tank. The overflow from this tank goes to the cooling tower on the roof. In this way the water is cooled and re-used during those periods when the meat processes require but a small amount. The amount of water passing through the condenser is so great that the temperature rise will be less than 5 deg. F. during the hot weather; the compressor discharge pressures are consequently very low.

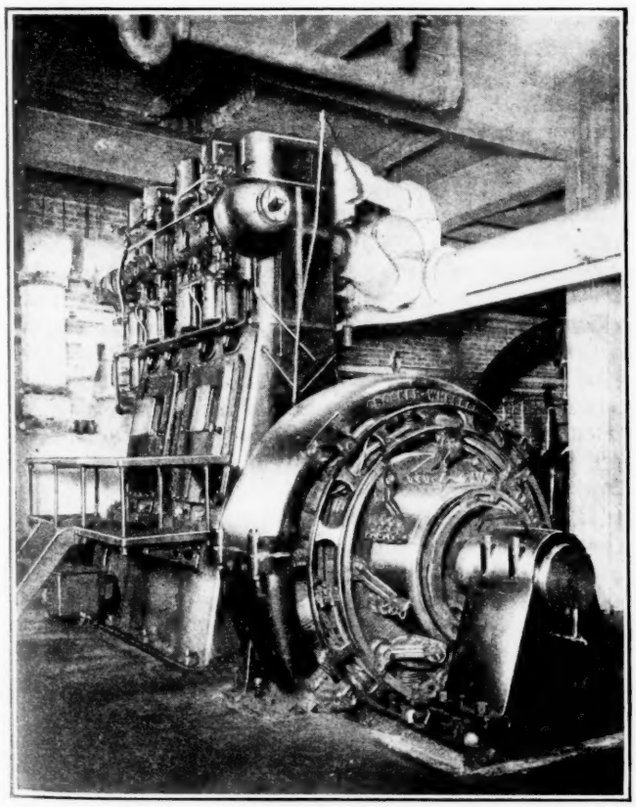


Fig. 3—New pipe layout at the vertical uniflow. Opening in ceiling permits removal of the pistons

The entire refrigeration for the plant is by brine. The refrigerator rooms are fitted with spray lines, the brine being re-cooled in open brine tanks in the engine room by the expansion of ammonia in pipe coils. For icing purposes a 10-ton ice tank is located in one corner of the engine room.

Jacket Water Cooling Omitted

The purchased compressor is of the horizontal double-acting type and is designed for jacket-water cooling. However, since it is difficult to hold the suction gas in a dry state, the suction is allowed to frost back to the compressor intake, and no jacket-water cooling is attempted. The slight amount of liquid entering the cylinder is sufficient to prevent any heating of the exposed cylinder barrel.

The entire work of dismantling and re-erection was carried out by the plant's engine-room force. The removal was difficult since the machines had to be raised through an elevator shaft to the street level and lowered through a similar opening at the new plant.

The disconnection of steam lines without interference with the operation of the remaining units was carried out at night when the load could be temporarily dropped.

The load of the new plant is carried mainly by the 300-kw. vertical uniflow and the purchased Corliss-driven compressor. The motor-driven compressor will be used only in case of emergency, and a breakdown service from the public-service lines will be maintained for it. The two smaller uniflows will be used on the night load and on holidays when the load is light.

"Priming and Foaming"—Correction

Attention has been called to the fact that readers may have been misled by Fig. 3 on page 332 of the article on "Priming and Foaming" in the August 31 issue. This cut shows "Tracyfiers" in place in the drum of a boiler. The continuation of the drain pipe to a trap outside of the drum is not shown. The text also states that the separated impurities are discharged into the drum.

This article (as was the case with the entire feed-water series) was an abstract of a chapter of a book which will be published shortly. The original unabridged chapter contains a cut showing clearly the actual arrangement. It is referred to as follows: "By this means the water is thrown out and runs back into the drum through the drain pipe in the bottom of the purifier. The water removed from the Tracyfier does not again intermingle with the boiler water, but flows through the drain pipe and discharges to waste through a trap. The general arrangement of the Tracyfier in place in the steam drum is shown in Fig. 6." The context likewise makes clear the point that the object of the purifier is not merely to remove moisture as such, but also all of the impurities suspended and dissolved in the moisture.

Safety First and Last
*in the Power Plant**

WHEN you stop to consider that each year about eighty thousand people die in this country as the result of accidents, and about two million more are injured, you can readily see how important it is to train and drill every man in your employ to be always on guard to avoid injury to himself and his fellow workmen.

I do not know what proportion of the total number killed or injured every year work in power stations, but I do know from my own experience that a great many men are hurt in power plants every day. Most of these injuries are of a minor nature and if first aid is given immediately, cause no further trouble, provided the first aid is given by someone who has had some training in such work and has the proper materials for treating small injuries or wounds.

Whether these injuries are great or small, most of them are unnecessary and are caused by carelessness on the part of the victim or someone else. Unceasing vigilance and persistent training—these and these alone—will keep down the awful toll of accidents.

AMERICA is the most productive nation on the face of the earth. That is the fundamental reason for our prosperity. Unfortunately, a spirit of waste and carelessness accompanies this high production and cancels part of the gain. Of all forms of waste, that of human life and happiness by preventable accident is the most insane. Read what an operating engineer of long experience has to offer in the way of practical suggestions for protecting the power-plant worker from the hazards that beset him.

Men doing the same work day after day get careless, or don't think, or take a chance, or are in a hurry to finish a certain job, when off goes a finger or a leg, or out goes an eye. There is a hurried trip to the hospital and maybe in a few days the men will all chip in to buy flowers for poor Bill.

Modern power plants are very safe as far as the apparatus is concerned, and so are the older plants. Where safety appliances once were lacking, these have been installed so that the old plants are often quite as safe as the newer stations. The fact is that there are not many more safety devices that can be installed on machinery; machines of almost all types are now about as safe as they can be made. If any appreciable reduction is to be made in this annual toll of life and limb, it must be done by education. This education, to be complete, has got to start with the man in charge and go right down through the whole organization to the tool boy. Great stress should be laid on safety first at the foremen's conferences, not only once in a while, but once a month at least until they know that it's up to them to reduce the number of accidents to a minimum.

A safety committee composed of men from the various departments is a very good way to get the men interested in this work. This committee should be changed every three months, so as to get all the men acquainted and familiar with safety first. What one group of men doesn't see or think of, another group may. It is also a good thing for the man in charge to talk with the various groups, and have outsiders who may be interested in this movement talk with them, pointing out what is being done in other places to avoid accidents.

Committee or no committee, the foremen must be the main stand-by; they are the ones who must be instructed and drilled to carry out the greater part of this work. They are with the men most of the time and have direct charge of the various jobs, so it is up to them to see that the men take no unnecessary risks in their work.

I rather think that accidents to the eyes are the most numerous. Men do not like to wear those monstrosities called goggles, and I don't blame them, but they are about the best eye protectors we have. They do get hot and covered with dust, but it is much easier to wipe off the goggles than it is to go through life with a glass eye or be blinded by a piece of steel or some other chip that may fly in the eye. The goggles should be worn when chipping, using the emery wheel or doing anything where there is the least possibility of getting anything in the eye that might injure it.

Boards or planks lying on the floor with nails sticking up through them have caused thousands of men to lose a foot or a leg or maybe life itself. Make it a practice to pick up or pile all boards taken from boxes or concrete forms so that it will be impossible to step on them.

Broken or wobbly ladders and stepladders are responsible for many broken legs and arms, as well as more serious accidents. When a ladder gets in this condition, throw it in the furnace, or destroy it in some other manner.

Old material lying promiscuously around the plant is very often an excuse for calling in the family doctor. Old steel beams, boards, broken bricks and other junk may cause someone to have a sprained ankle or fractured shin, if nothing worse.

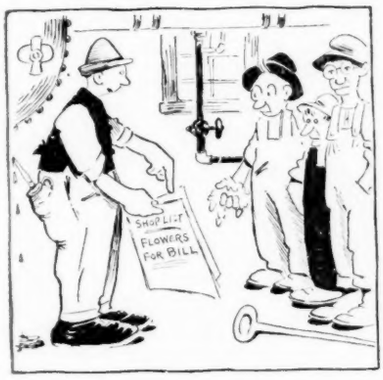
Twisted or warped planks used in staging are likely to dump someone in the sump. When used for higher scaffolding, they may result in a broken back or neck, and maybe several of them. Planks so twisted should never be used except for firewood.

Some of the most serious accidents have been caused by leaving temporary openings in the floor unguarded for just a few minutes; someone happens along and

*The author, who is chief engineer of a large station in the East, withholds his name for personal reasons.

down through the hole he goes. If that hole had been guarded with a rope or wooden rail or covered with planks, the ambulance would not have been called. It is the rankest kind of carelessness to leave an opening unguarded, even for a minute.

Of course all permanent openings or stairways should be guarded with strong handrails. Sometimes these handrails get loose or broken and in that condition are worse than none. When John tries to rest by leaning



And maybe in a few days all the men will chip in to buy f l o w e r s for poor Bill

against the rail, he goes to a place where he can have a permanent rest and no handrails are needed.

Flywheels, gears, belts and any moving machinery where a man can get caught should be protected in such a way that it is impossible to get into them. Handrails may do; where they are not sufficient make guards of heavy steel wire fencing.

Most elevators are equipped with safety gates, but not all. Those so equipped are all right when the gates work; when they don't work, they are all wrong and should receive attention before someone falls down the elevator shaft. Those not having safety gates should have some automatic device for protecting the shaft when the elevator is not at that floor. The other automatic appliances on elevators get out of order from time to time and should receive just as much attention as the stenographer in the bosses' office.

Poor lighting is another cause of numerous and varied injuries, all the way from stubbing your toe and biting your tongue to falling down stairs and breaking your neck or somebody else's. There is almost no excuse for not having proper light; one serious accident will cost more than all the necessary lights would amount to in several years. Stairways and all openings should be especially well lighted, the lights so located that they cannot shine in one's eye when going down stairs.

Emergency lights should be provided and installed at such places as need general illumination, as well as at stairways and other dangerous places. These lights should be connected to a separate storage battery or the control-switch battery, and should be tested every day to make certain that the automatic emergency switch is working properly and that no lights are burned out. In addition to the emergency circuits just mentioned, oil lamps should be set at all necessary and important places and lighted every day before dark.

Fuses and all automatic electrical devices for opening circuits should be inclosed or protected in such a way that when they blow or open, there will be no possibility of anyone's getting burned. All wiring should be protected in the same way; many a man has taken a ride in the hurry-up wagon because wires were run in a careless manner or the insulation was poor.

Traveling cranes, like all other machines, have to be looked after. They need oiling or greasing; the cables or chains should have a little attention, and occasionally a new part is needed, but not often. A good safe ladder is required to reach most cranes, and should be provided; the practice of walking along the crane track to go to or from the crane should not be allowed.

No man should be allowed on a crane unless he is used to working in high places and has good eyesight. Once in a while an operator gets rambunctious and thinks he is driving his flivver along some speedway, until he strikes the end of the building, maybe wrecking the crane as well as himself or someone else. Overloading cranes is bad practice, and generally unnecessary; you know the capacity of the crane and the load to be lifted. If it is too heavy, don't take a chance unless it is absolutely necessary. At least make certain that no one gets under the crane while it is overloaded.

Rigging of all kinds should be kept in good condition. When a rope is stranded, don't use it. If necessary to use it, cut out the stranded part and have a new splice made. The sheaves in blocks need oiling to keep them safe as well as easy to use. When moving heavy pieces on rollers, see that no one gets his foot under the rollers; it may slow up the job and incidentally smash the foot.

Chain falls may get you into trouble if they are not kept in the pink of condition. When they get strained, they should be sent to the shop for overhauling before they are used again.

All tools that are badly worn are dangerous things to have around. Monkey wrenches, stillson wrenches and open-end wrenches that are strained and sprung should be sent to the junk pile; they have a bad habit of slipping when in a tight place and may let Jim take

It is much easier to wipe off the goggles than it is to go through l i f e with a glass eye

a header to the basement floor, or hit Tony a crack in the jaw, making him swallow a few teeth if nothing more. Cold chisels that are tempered too hard or whose heads are all flattened out, may snap off and fly into Bill's eye, doing more harm than he can repair in a month, or several of them. Worn hammers, with split handles, can also cause a lot of grief.

It is not necessary to use tools like these, the company doesn't want you to use them; they and the poor devil that gets hurt are the losers when this kind of tool is used. You can rest assured that when tools like I have just described are used, and someone gets hurt, the powers that be will pin no medals on you for trying to economize.

Skylights or other glass in roofs of buildings must come in for regular inspection and regular maintenance to avoid the possibility of a painful or maybe serious accident. A word to the wise is sufficient. A one-inch wire screen under the skylight will catch any glass that may fall out.

Pipes are often run so low that it is impossible to pass under them without either hitting them or stooping. Now it's all right to stoop when there is plenty of time and the light is good, but when the lighting is poor or a man is in a hurry, he may not think to stoop. Where pipes are low enough to bump the head or low enough to be tripped over, they should be protected so that a man cannot bump into them in the dark.

Bursting gage glasses on boilers or receivers have given many a man nasty cuts and burns. There are several safety devices on the market to prevent such accidents, and it is a good investment to install them if these gage glasses are low enough to fly and hit someone when they burst.

Safety valves have a bad habit of blowing when someone is in range of the business side of them; if a man does not happen to get burned he is lucky, but the chances are he will be scared to death, or nearly so, and that is almost as bad. Lead the discharge side of the valve up through the roof if possible; if not, lead it up high enough so it is over a man's head.

When it is necessary for a man to work where it is very dusty—and there are a number of such places in power stations—he should always cover his face, or nose and mouth, with cheese cloth or some other protection, to keep the dust from going into his lungs. The gas mask is better than the cloth, especially if there is any possibility of gas. It is true that most men don't like to wear gas masks, but a little persuasion will help. After the first shock is over they will get used to them and there will be no further trouble. Gas masks are good things to wear when cleaning condensers, especially where there is much sewage in the condensing water.

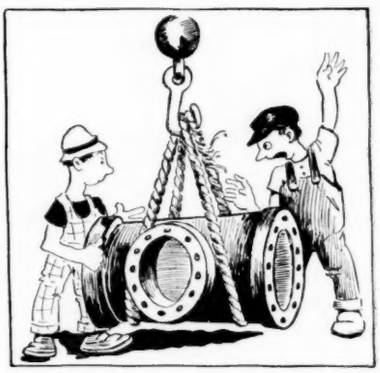
Boards or planks with nails sticking through them have caused thousands of men to lose a foot or a leg

I could write a book on the number of men who have been hurt, and some of them very seriously, as a result of fooling or horse play, but I'm not going to—not at this time. I'll wait and see if you habitual kidders and fellows that like to put up jobs on the other fellow cut out your nonsense before I write it. But at any rate, boys, cut it out; there is nothing in it. I went through the mill and I know.

Inflammable materials composed of oils, paints, varnish, gasoline, etc., should always be placed where there is no possibility of fire. The fire risk itself is bad enough, but there is the danger of an explosion, and of someone being injured. Gasoline and kerosene tanks should be buried underground. The other things mentioned should be kept in a fireproof room, with smoking or lighted matches absolutely debarred.

Another hazard is the empty oil barrel, which, like the empty gun, has sent many a man to the hospital. The barrel is empty—at any rate Joe thinks it is—but to make sure it is empty he lights a match so he can see the bottom of the barrel. It is needless to say that the barrel is empty long before Joe reaches the hospital. If it is necessary to look in, use an electric light, and ventilate the barrel before being too inquisitive. All empty barrels that have contained volatile material should be classed as dangerous.

Rigging of all kinds should be kept in good condition; when a rope is stranded, don't use it



There is no way of stopping accidents altogether, but we can greatly reduce those that are caused by carelessness, which is responsible for 90 per cent of the total. There is not an accident described here that I have not seen, and some of them many times. All were due to the carelessness of the man or men injured, or of someone else. A little vigilance on the part of the men or foremen would have prevented most if not all of these accidents.

Standardization

The following was collected by our friend, John C. Jones, vice-president of the Cochrane Corporation, at a recent meeting of the District Chiefs of the Ordnance Department. Author unknown.

The New York joint to the Utah pipe,
The pipe to the joint in Dover,
And the half-inch nut to the half-inch bolt,
Ever the wide world over;
Ever the wide world over, lad,
Even the thread that's true—
Over the world and under the world
And never a misfit screw!

Follow the standardized hardware trail
West to the sinking sun,
Where the plumber plumbs and merrily hums,
For his labors are blithely done;
Follow the trail of the standard bolt
East to the shipwright's lair,
Where each nut fits, and the workman sits
With never a cloud of care.

The lag screw to the motor car,
The pipe to the kitchen range,
And the northern bolt to the southern nut,
With absolute interchange.
Absolute interchange, my lad,
Threads that will always meet—
System at last in the hardware trade,
And the world is all at our feet!

Never Send a Boy To Do a Man's Work!

ONE small city in the United States has spent twenty thousand dollars for expert guidance in smoke abatement and has succeeded in eliminating all its worst offenders. One large city, proud and boastful of its accomplishments, each of which is alleged to be, in its own field, the biggest and best in the world, has set a salary of $3,460 per year for a chief smoke inspector under whose leadership they hope to clear up their dirty atmosphere.

Never send a boy to do a man's work!

Smoke abatement is a tremendously difficult task. It demands a thorough grasp of the subject and involves instruction and persuasion under circumstances to tax to the utmost the abilities of the engineer, of the teacher, of the salesman, and of the leader of men. A big man can accomplish splendid results. It has been done. A small man can accomplish nothing. That, too, has been done. The pity is that it is to be repeated.

Where Will Industrial Plant Pressures Stop?

THE number of industrial plants that have gone to high steam pressures during the year leads one to speculate as to the probable maximum that will be reached and to what extent the pressures will become standard for a period at least.

A number of firms have adopted four hundred pounds and one has gone to seven hundred pounds. In most cases the upper limit is more or less fixed by the process steam-pressure requirements and the most economical range for the high-pressure turbine.

Up to a year or two ago turbine manufacturers were not prepared to offer small units for industrial plant use, operating between such pressure limits and having a fair degree of efficiency. After considerable work, however, this part of the problem seems to have been solved and many such turbines have been and are being installed.

Of course, manufacturers of all boilers and other equipment going into such plants are directly concerned in this pressure transition, and many are wondering how far to go in equipping their shops to take care of the demands for high-pressure equipment. If practice is likely to settle around four hundred pounds, the way will be clear, but if the tendency is to exceed this, many manufacturers will prefer to stand by and watch the procession for a while.

The problem is somewhat different from the trend toward high steam pressures in central stations, where most of the equipment is large, the number of manufacturers of major equipment fewer, and much of the apparatus special. The continual strife for better economies is so keen as to warrant the expenditure of much money on development work and special designs, which, of course, go to increase the fixed charges. In the case of the industrial plant, however, few managements care to stand the expense of development work in power apparatus, and it is here that more or less standardization is desirable.

Opinions of those whose experience and affiliations may render their judgment worth while, would be welcomed both by power-plant owners and by manufacturers who must supply the necessary equipment.

Middle Age and Opportunity

WHY is middle age (say forty-five and over) a serious impediment to an engineer looking for a job? Without attempting to formulate a definite answer to this question, one may well ponder the matter a little.

Now, as always, there are engineers out of work. Among them is a fair sprinkling of competent men who, though experienced and apparently competent, seem unable to land worth-while jobs. We are not concerned here with chronic failures, but with men who have held positions of responsibility for years. Industrial changes, new management or internal politics sometimes turn such men loose through no fault of their own. In many instances they experience great difficulty in making new connections of the right sort.

What is the reason? Does the mere fact that a man over forty-five is seeking a new job cast suspicion on his ability as an engineer? Should he be willing to start again at a lower salary in view of the fact that he cannot be as familiar with a new plant as he was with the old? Is it harder for the middle-aged man to adjust himself to a new environment? Is he generally the worse for wear, mentally and physically? Does the employer prefer young men because they will start for less, or is the longer period of possible service a consideration? Finally, is it possible that some of these experienced middle-aged engineers are poor salesmen of their own abilities? These are merely questions set down without bias. Perhaps some reader may see clearly the answer.

Automatic Control for Refrigerating Plants

WHILE various details in equipment have been improved or even redesigned, the compression refrigerating plant is practically the same as it was twenty-five years ago. Power generating apparatus has undergone notable advances until now the operation of a large central station is well-nigh automatic. From automatic voltage regulation through combustion control systems to automatic coal weighers, the effort has been to remove the personal equation as much as possible from the operating problem, for mechanical brains

have proved to be more reliable in their functioning than the human brain. On the other hand, although there are many automatic household machines, commercial refrigerating systems rely for their correct operation upon the number and character of convolutions of the engineer's brain. Consequently, the operator is constantly making control adjustments that could be better performed by automatic devices, leaving the operator to devote his time to greater advantage.

The evaporating system, although improved by conversion into a shell-and-tube brine cooler, still has its supply of liquid ammonia controlled by hand manipulation of the expansion valve. Unless the supply be reduced at a decrease in refrigerating load, liquid may fill the coils or the cooler tank and be carried over to the compressor. One design evolved to overcome this includes the use of a large suction separator provided with a trap and a pump. The latter discharges the separated liquid into the high-pressure side, and the flow through the expansion cock is kept constant.

Another suggestion is to make the evaporating system in the form of a circuit, with a pump placed in the line to handle all the liquid in the coils. A float would control the liquid level, and by the use of a large drum or other device, ample disengaging surface would eliminate the vapor separation in the coils. Being under a low pressure, pump leakage would not be likely and the small resistance would make the pumping power insignificant. Float control would insure against a wet suction, and the forced circulation would decrease the amount of coil surface needed. By using the proper motor, the circulation velocity could be changed with a change in refrigerator temperature, thereby permitting the compressor's suction to have the same pressure and temperature characteristics.

Now Is the Time for an Agreement

STRIKES in the coal industry, like the poor, are always with us. For a good many years, with almost clockwork regularity, they have come and gone, and the possibilities of another one for next April is more menacing than the industries of this country care to contemplate. It would be of great interest to manufacturers and others if they could be given assurance that they will not be subjected to the effects of another period of suspended operation in the union coal fields next year. Not only is this of interest to industry in general, but it is also to the benefit of the coal miners and operators that this information be made available in the near future.

The Jacksonville wage agreement, under which the last strike in the union bituminous coal mining districts was settled, expires the first of April of next year. According to this agreement the contracting parties are to hold a meeting in February, 1927, to negotiate a new compact. Past experience has shown that meetings called before the expiration of an agreement in the coal industry have generally been the occasions for disagreement and the struggle preliminary to a suspension of operations. With such precedents for guidance, there is only one way to deal with the situation, and that is, to store coal. At this time, when there is a rising market, this should be done with discretion, since there are five months yet in which to build up the reserve stocks, before a coal strike may occur.

Demands to help meet the requirements in Great Britain for coal, due to the strike, and the increased amounts going into storage in this country in anticipation of what may happen next spring, have greatly improved the situation for both the operators and miners. This improvement is, however, only temporary, since the conditions in England will eventually be cleared up. Any excess coal stored in this country means a suspension of purchases at some future date while this is being burned, during which period the demands on the mines will be reduced. If the operators and miners wish to stabilize their industry, purchasers should be given assurance now that there will be no suspension of bituminous coal mining next year.

The storage of coal in anticipation of a strike in this country is an expensive operation, tying up a large amount of capital. It is predicted that if no definite assurance is forthcoming as to what is going to happen in the industry next spring, seventy million tons of bituminous coal will be put into storage. Part of this represents the storage under normal conditions, but at that it means a tremendous expenditure to insure against an emergency that is avoidable by a little intelligent action on the part of those on whom the country depends for a coal supply. Taking this amount of capital out of natural channels cannot fail to have an ill effect on industry in general, but until given an assurance that there will be no coal strike next spring, there appears to be but one safe course to follow and that is, to store coal.

Put Safe Men in a Safe Plant

THERE is one safe berth for a careless man—a pile of fireproof hay. Anywhere else he is a business builder for the doctor and the undertaker. He certainly has no legitimate place in a power plant, where the damage that can be done by a simple slip in technique is appalling.

No responsible engineer would knowingly hire a careless man at any price, but such get in now and then and do a lot of damage before they are found out and let out.

It is not worth while for the power-plant executive to try to re-educate a thoroughly careless man. There are, however, a great number of average human beings who, while not notably careless, tend to fall into dangerous habits if not watched and corrected. For such men and their bosses this issue's article, "Safety First and Last in the Power Plant," should be of value. From long experience the author has learned the principal danger points. These are mostly little things—failure to wear goggles where the work endangers the eyes, nails in loose boards, unsound ladders, junk lying around the plant, weak staging, unguarded openings, lack of handrails, unguarded machinery, unsafe elevators, poor lighting and so on.

With the growing standard of intelligence and increasing regard for the health and happiness of industrial workers, faults such as these are less common than formerly, but many plants still leave much to be desired from the safety point of view.

But it is not enough for the man in charge to make his plant shipshape and remove, as far as possible, the physical causes of accidents. He must also secure the cordial co-operation of his men. Without that no safety campaign can be more than a half success.

Practical Ideas From Practical Men

A Peculiar Uniflow Engine Valve Trouble

One night recently, a poppet-valve uniflow engine, while carrying its share of the peak load, gradually slowed down and stopped. The remaining units were not of sufficient capacity to carry the additional load, with the result that the entire plant had to be shut down. As quickly as possible all the units, including the uniflow engine, were started again. The culprit engine then carried its full load through the peak period, but there was a considerable knock in one end of the cylinder. As soon as the load could be carried by the other units the engine was shut down and the valve housing and mechanism were removed to locate and correct the difficulty.

At first an effort was made to lift the entire valve housing and the valve with the crane, but the lower part of the valve disk could not be drawn past the seat. The housing mechanism was then disassembled and removed alone, leaving the valve and its stem in the cylinder. The housing out of the way, the cause of the trouble was visible. Scales of what appeared to be carbonized oil had wedged between the valve and its seat. Furthermore, it was found that the unfinished concave surfaces of the valve and the adjacent surfaces of the valve cavity had on them a coating of this scale, about $\frac{3}{32}$ in. thick. From this had dislodged the particles that caused the shutdown. The valve and valve cavity were carefully cleaned of this deposit and the parts replaced. The engine was put into service again at the usual time the next day and has been carrying its load satisfactorily ever since. Incidentally, the other valve, on the head end of the cylinder, was similarly removed, cleaned and replaced.

Apparently, the shutdown was caused by a piece of this scale having become lodged between the valve and its seat. This permitted simultaneous entrance of steam to, and equal steam pressures on, both ends of the piston.

The theory evolved to account for the formation of the scale was that engine oil had probably been used at some time for lubricating the valve-stem mechanisms within the valve-stem housing. During the exhaust period the vacuum had drawn some of the surplus oil down around the valve stem and into the valve cavity. Being only engine oil, it was carbonized and deposited on the interior surfaces of the valve and its cavity.

Obviously, only the exclusive use of cylinder oil that will successfully withstand the higher temperatures, will prevent this kind of trouble. For successful use of the cylinder oil, the oil cups for lubricating the valve stem and the mechanism within the housing must be in such locations that the cylinder oil in them will be constantly at a sufficiently high temperature to insure fluidity.

C. C. FARRELL.

Houston, Texas.

Diagnosing Troubles of Electrical and Mechanical Type Flow Meters

Steam-flow meters generally consist of two elements. The primary element, either a flow nozzle or pitot tube with suitable pipes and reservoirs, is installed in the pipe line and produces a differential pressure. The secondary element consists of a pressure-tight manometer which is connected to the reservoirs of the primary element and which has some external device to indicate, record or totalize the deflection of the manometer in the terms of flow. Mercury is generally used as the working fluid, in the meter.

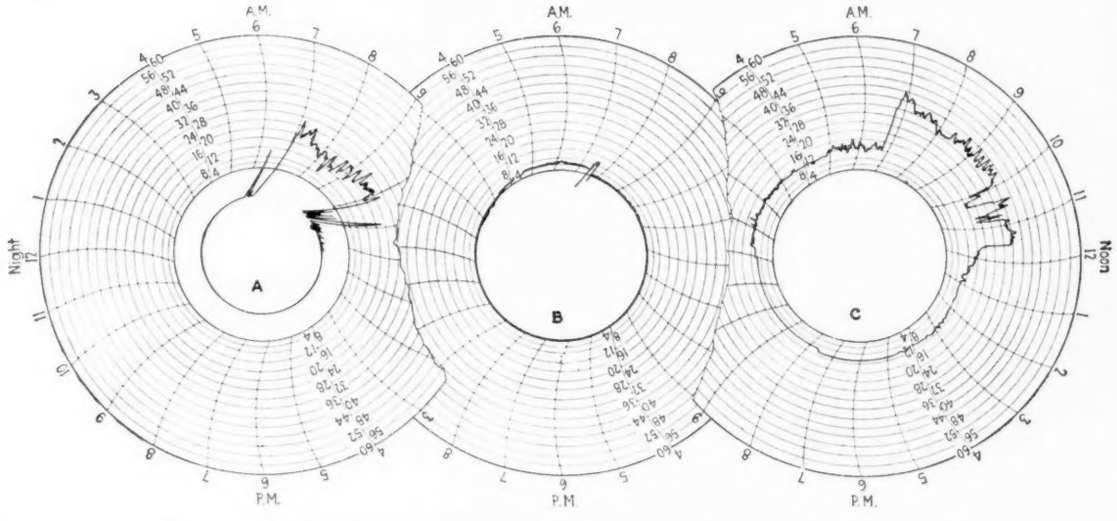


Fig. 1—Charts show the effect of leaky connections on the meter record

It is the purpose of this article to show how the numerous troubles connected with electric- and mechan-

ical-type flow meters can be diagnosed by means of the graphic charts. Their causes are shown and their remedies suggested.

In the first place, one of the most essential points to the successful operation of all types of flow meters is to have tight pipe connections.

The chart *A*, Fig. 1, shows results obtained after a boiler meter was checked for zero, put into operation

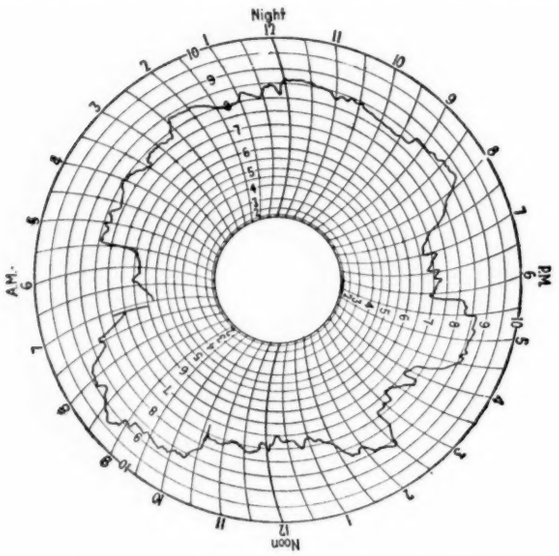


Fig. 2—Long drawn out curve indicate meter operating sluggishly

and then developed a leak on the leading side where the nipple goes into the condensing chamber. The leak caused the pen arm on the meter to move to a point below the zero line on the chart. After the leak was fixed the pen arm came to zero on the chart.

Chart *C*, shows the case of a flow meter that developed a leak on the trailing side and caused the pen, during the banked hours of the boiler, to record above the zero line. It will be noticed that had this chart been taken as recording actual flow, it would be high by many thousands of pounds.

A meter has been known to show steam charts with a number of smooth drawn out curves. A sample chart of this condition is shown in Fig. 2, and it can be suspicioned that the meter has become sluggish in its action. This sluggishness is due to accumulations such as pipe scale and foreign matter settling on the surface of the mercury in the meter. Recently, I encountered a meter that became sluggish after being completely overhauled and calibrated. The meter pipes had been thoroughly cleaned by blowing steam through them, but still the action of the meter was sluggish. However, after some deliberation, it was found that the man helping to overhaul the meter had poured the mercury for it from the regular earthenware container into an old tin can and from there into the meter. Since the mercury displaced the tin and formed a tim amalgam, this formed a surface coating on top of the mercury and the float in the meter would not respond readily to the rise and fall of the mercury level.

Chart *B*, Fig. 1, was taken from a boiler that had been out for 24 hours. For some reason the voltage regulator was not maintaining a constant voltage, and later it was found varying by about five volts from its normal voltage. As a result, instead of having just enough current as an exciting current to make up merely for the transformer-iron losses and maintain the pen arm on the zero of the chart, this current had increased because the voltage had increased. After the regulator was reset, the true zero was again found.

As a final thought, it might be added that the troubles of flow meters are few when operating under certain conditions, but their peculiarities under other conditions are indeed mystifying. It has been my experience that where two steam mains are connected in such a way as to feed the same units, a steam-flow meter in each one of the lines will not operate satisfactorily.

Lynn, Mass. H. J. BEADLE.

Machining Vertical Shaft in Place

In our hydro station we recently found it necessary to true up the vertical shaft shown in Fig. 1 at each bearing. Having inadequate means of handling the heavy shafting, we decided to true it up in place. To do this work it was necessary to construct the machine shown in the illustration. The only dismantling necessary was the removing of the bearing casings.

Referring to Fig. 2, the cylindrical shell *E* is clamped to the shaft directly above the bearings by bolts on top and semicircular plates and capscrews on the bottom. The outside of the shell is machined, as is also the face that bears against the shaft. The cylinder *F* is made a running fit on the shell *E* and is driven by the gearing and a splined shaft *D*. Attached to this cylinder at the bottom is the head *G* which carries the adjustable cutting tools *J*. The cutting tools are fed in

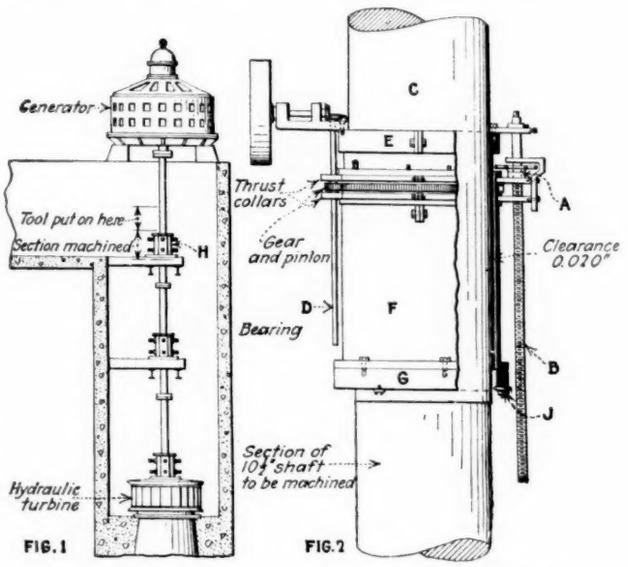


Fig. 1 — Arrangement of shaft and bearings

Fig. 2 — Shows the tool clamped in place on the shaft

by a small screw, and the cylinder is fed down by the star wheel *A*. Feeder buttons slipped over pins on the upper end of the outside shell turn the wheel and the rate at which the tool is fed forward depends on the number of buttons that are in use. The turbine shaft was 10½ in. in diameter and the journals were 19 in. long. The machine worked satisfactorily and the job was finished in shorter time and at less expense than if the shaft had been removed and sent out for machining.

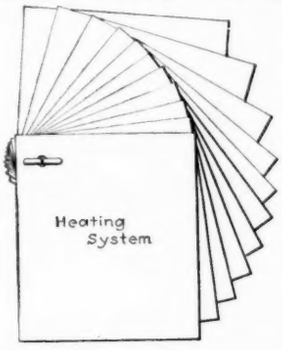
ED SWAN.

Kearney, Neb.

Comments from Readers

Distinctive Colors for Piping

It seems that the matter of properly painting lines for identification will never be settled, judging from the frequent items published on the subject. Nevertheless, a good code can be made up without difficulty. The trouble is that many a color plan, good for the single plant, has been condemned by reason of variation from the general trend of existing codes. If uniformity as between users is deemed of so much importance by many engineers, others should at least concede its desirability within the individual plant.



Cardboard squares printed on one side and colored on the other designate respective services

Where large corporations have extensive piping systems in long tunnels and elsewhere, and in particular where these systems contain pipes carrying contents of a hazardous nature, and wherever the labor turnover for pipe repairmen is large, it is advisable to adopt some systematic method of readily identifying the network of piping. Even in the small plant the slight trouble of color-banding the pipe at suitable intervals according to the case of the painting of fittings with distinctive colors, will be more than offset by the time otherwise spent in tracing a pipe back to connections, equipment or other source in order to learn its contents.

During a continuous four-year appraisal of mechanical equipment of many public utilities I learned that no dependence could be placed upon the average maintenance engineer for knowledge of the piping, and that this was true more in the small than in the large plant, where a higher or more experienced grade of help is generally employed. But in all cases where the piping was colored, there was no trouble in defining the various services—a condition that would be of advantage to any operating engineer, new on the job. Once used, he would not be without it. Of course, the piping within the boiler plant itself need not be colored if the rooms are well lighted.

Frequently, we find rooms in other compartments from which the piping leaves in different relative positions from those in which it enters. The kind of fittings on unlike lines is probably the same, but even if different, of what avail where covered? On the other hand, properly designated by colors, the contents would be readily known. As for where the pipe goes or what it shuts off, use as customarily used heretofore a plant piping diagram and valve chart for each service, or else a valve schedule with each valve properly tagged. This part of the problem is not the work of a color scheme.

No one need rely on color memory if he will use a simple method of cardboard squares colored on one side and printed on the other to designate the respective services. The cardboards, which are 1½ in. square, are secured by a clip around which they may be easily rotated as illustrated. These small color charts, suitable for the vest pocket of the steamfitter, are likely to be on hand for comparison when required.

The ideal color code should be easy to learn and to remember in emergency and excitement. It should tell its story plainly to persons of varying color vision. This demands simplicity rather than a complex code giving the last word in detailed classification to cover all conceivable cases.

T. W. REYNOLDS.

Highlands, N. J.

Catching the Employer's Eye

Recently, one of the large corporations here sent to its foremen for their comment a clipping, entitled, "Catching the Employer's Eye," in which an efficiency engineer asked a young man in a large factory to suggest some means for increasing the company's business or saving them money. The young man failed, as the article stated, to find any way of doing this.

If the efficiency engineer were to ask me the same question, I could tell him of several ways, but I am afraid that he would take the same attitude that the average plant owner does when he found out what it would cost to effect a saving.

There are several things that could be done in practically every plant that would save fuel, but unless the plant is fully equipped it is hard to prove it on a dollar and cents basis. In power plants the different pieces of equipment are usually so closely allied that we cannot make a change in one without affecting the others. As an example, let us assume that we have a plant of several thousand horsepower, supplying light, heat and power to a factory. We decide that by putting in, say, automatic damper controls we can save, but after installing these we find that our fuel consumption is higher than before. We are then likely to jump to the conclusion that the controls are useless, but we cannot prove this for we have no means of checking the load on the plant to show if there has been an increase or not. If the fuel drops, we are likely to "pat" ourselves on the back, and say that the controls are the real thing. Again, we have no way of proving this.

Now, if we had flow meters to show what amount of steam was used in the turbines, heating system, etc., recording wattmeters to show our electrical output and CO_2 recorders to show the condition of the combustion—in other words, if we were fully equipped—we could put our finger on the weak spot in a minute. But with only one thing being checked, out of the dozen of other things that are taking place in the generating and distributing of the power, we cannot tell what the unchecked ones are doing or prove that the one we are checking is right or wrong. How can the engineer who is operating several boilers, tell which ones are "soldiering" on the job? How can he tell which of the

various units in his plant are efficient without some means of checking them up?

You equip your office with adding machines, cash registers and every known way of catching the stray penny that is trying to steal past, but while the adding machines will show that there is a loss in the power plant, they cannot show where it is. You put into the bunkers thousands of dollars in coal every year and run it through the plant without any means at all of telling where it goes or how much of it is used and how much is lost. Your bookkeeper is prepared to grab the various items that show a loss and pin them to the wall, but the engineer is running around in circles, trying to catch these losses. You equip the factory with every piece of equipment that will increase production and lower cost, while the engineer in the power plant plugs one leak and hopes that it will stop all the others. The trouble with the system is that the management requires that each appliance pay for its "keep," when it cannot pay for its own and half a dozen others.

We have several thousand feet of live steam pipe laid in the ground with no covering except Mother Earth and more bare steam piping overhead, yet when the coal bills run high and the engineer tries to tell about the loss of condensation in bare pipes, he receives a shrug of the shoulder. THOMAS M. STREET.

Wilkesbarre, Pa.

The Fuel Unit

There have been several expressions in *Power* of a desire for a unit with a name to express large quantities of heat. Why not adopt something big enough to start with? The unit 1,000,000 = 10^6 B.t.u. is rather convenient and has been used more or less. The expression "10^6" Cal. is frequently found in foreign technical literature. This "fuel unit" is equivalent to 1,000 cu.ft. of natural gas at 1,000 B.t.u. per cu.ft. or 2,000 cu.ft. of coke oven gas at 500 B.t.u. per cu.ft.; 26 "fuel units" = 1 ton of coke at 13,000 B.t.u. per lb.; and 28 "fuel units" = 1 ton of coal at 14,000 B.t.u. per lb., etc.

When the value of a fuel is to be considered, it is necessary to remember: That the thermal value of a fuel does not give any indication of the thermal potential or pyrometric value of that fuel; that the value of a fuel for any particular service depends upon the quantity of heat it will make available above the ruling temperature of the process, that is, between the pyrometric temperature obtainable with the fuel and the temperature of the waste gas from the heating chamber. The pyrometric value of the fuel indicates the amount of heat released. The waste gas temperature indicates the heat carried away. Their difference indicates the quantity of heat available for utilization. Excess and deficiency of air supply reduce the amount of heat available, the former by carrying off a greater quantity of heat in the waste gases, the latter by carrying away undeveloped heat in the waste gases. In both cases the pyrometric value of the fuel is reduced, which reduces the thermal potential available.

Combustion or oxidation of a combustible follows chemical laws, the highest reaction velocity being obtained when there is a slight excess of the oxidizing agent and the fuel and the air are mixed at a high temperature. Chemical and physical laws governing these reactions, it should be remembered, are immutable and inviolate. A. D. WILLIAMS.

Cleveland, Ohio.

Causes of Turbine Vibration

I have been following the recent discussion regarding the elimination of turbine vibration by proper starting of the unit. Many different methods have been given, and they are no doubt correct for the particular turbines covered. Details covering all machines cannot be standardized. Arrangement piping, equipment and types of turbine must be considered.

Regardless of the type of machine, care and judgment must be exercised in warming up before starting. It is possible to overdo the matter, particularly with superheated steam. If the turbine could be warmed evenly all over, it would not become overheated before starting, but as long as the rotor is standing still, this is impossible.

With small quantities of steam flowing through the turbine, the hottest steam will remain above, falling to the lower portion as it is cooled. The natural result is that neither the spindle nor cylinder will be straight and the former will run out of true as soon as it is revolved. It is much better practice to warm the turbine only slightly and get it revolving as quickly as possible and do the greater part of the warming after the spindle is in motion. The higher the superheat the more important it is that the machine shall not be allowed to stand for any considerable length of time with steam blowing through it. In the old days with saturated steam this heat stratification did not occur, because the density of the steam did not change as it gave up heat. Consequently, the machine could be warmed up with the rotor at rest, and you will still find many old-timers who insist on following this method in spite of the danger involved.

I have not noticed any descriptions of starting methods for machines with water-sealed glands. With water glands the turbine should be started up non-condensing and not subjected to a vacuum until it is revolving fast enough to seal the glands effectively.

If a vacuum were established in the condenser or the air pump operated with the spindle at rest, or before the glands were sealed, air would be drawn in around both ends of the shaft, resulting in some distortion and making it run out of true and vibrate until the heating became uniform throughout. If a jet condenser is used without a gate valve between the turbine and condenser, some means of forced injection must be provided so that the turbine can be started non-condensing and the vacuum established afterward.

The throttle should be opened until the spindle turns over and then closed until there is just enough steam flowing to keep it revolving. After about fifteen minutes it can gradually be brought up almost to speed, gland water turned on, vacuum established, and then the machine can be put under the control of the governor. Little time need elapse between first cracking the throttle and the time the spindle is started revolving, three or four minutes to warm up the valves and chest. Unless load is to be put on the turbine at once, it is best to maintain a low or moderate vacuum until just before the load is put on. If there is any danger of the boilers priming, the load should be built up gradually to avoid a sudden steam demand.

When shutting down the turbine, the vacuum should be broken as soon as the turbine throttle is closed and before the machine slows up sufficiently to unseal the glands. Otherwise cold air will be drawn in through the glands and distort the spindle as before. After the

vacuum is broken, the gland water should be shut off, because if it is not it will be almost certain to leak over into the bearing and pedestal oil reservoirs and mix with the oil.

With certain fundamentals of oil pressure, steam pressures, gland sealing and vacuum fixed in their proper place, the many details can be fitted in between to meet conditions of each individual installation. It is certain that an improperly warmed up turbine is responsible for a great deal of the vibration reported. Many turbines that have reputation for starting bumpy, can be smoothed out by changing the starting sequence and having both the spindle and cylinder evenly heated when bringing up to speed. F. BRIGGS.

St. Petersburg, Fla.

Opportunities of the Engineering Graduate

I have been following the articles in *Power* concerning the opportunities of the engineering graduate in his chosen field. The parts of them that I object to are the comparisons with the medical graduate. The engineering training is not comparable to the medical training. The time of each is not the same and this destroys the comparison. Medical training is from three to five years longer than is engineering training. We would not think of running a series of articles on the comparative opportunities of the ordinary college graduate and the high-school graduate in a certain field. For the same reason we should not compare the doctor and the engineer.

My point is that if we wish to place the engineer on the same plane as the doctor, we must give him equal training. The engineer does not begin technical study until his junior year in college, the first two years being given over to preparatory study for his technical work. This brings us to the point of a "pre-engineering" course. If we had such a thing, the engineering student could "take off" his mathematics, English, literature, history and all the other cultural and preparatory courses given at the present time in his engineering curriculum. This would give him more time to devote to technical study while in the engineering school. The medical and dental professions have adopted this plan, and I believe the engineering professions should do so. The medical profession adopted it in 1916 through its national professional society, as a need for the elevation of the profession, and the last two years has brought the same thing in the dental profession. Why should it not be done in the engineering profession in the next five years?

There is another idea which I have in mind, and I believe if it were refined, it would place the engineering profession where it rightfully belongs. The medical profession requires at least a year's service as an interne and state professional examinations at the conclusion of it. I believe it is possible to establish an "engineering hospital," at first under the direction and support of leading technical institutions and later under their own support. In this "hospital" the small members of the industrial world who cannot afford to hire expert engineers, and also the large corporations who retain consultants, could bring their engineering problems for "treatment" by "internes," who would be under the direction of an expert engineering staff. After the engineer's service as an "interne" he should be required to take a state professional engineer's examination in order to practice. This would be a great aid to industry, and I think it would greatly elevate the engineering profession. I believe that the engineering field is just as big as the medical field, for no man can know everything that is to be known about medicine or engineering.

Pittsburgh, Pa. D. M. HEIDER.

Judging from the articles that have appeared in recent issues of *Power*, it would seem that there is still some prejudice against the engineer graduate. Probably it is a good thing that articles on this subject appear from time to time, so that college men in the field and those in charge of engineering schools may be reminded that there remains much to be done to fit the student properly for the position he is to fill after graduating. Much of the criticism is not just because the engineering graduate is the product of a system for which he is not responsible. One should, before criticizing the graduate, learn what he was taught and how he was taught.

Most of the criticisms of the engineering graduate are of a practical nature. He is ridiculed because he cannot "thread a pipe" or does not know some of the simple practical fundamentals. It is not the purpose of the engineering schools to teach pipe threading or how to drive rivets or roll boiler flues, nor do they have textbooks on practical fundamentals. Their purpose is to train the mind of the student to think quickly and accurately, and to teach him the theoretical part of engineering. The instructors are theoretical men and teach principally by a system of lectures. Thus the student acquires his engineering education in an atmosphere that would tend to make him feel that he is in possession of engineering knowledge of great importance and that much will be expected of him when he is on the job.

We cannot, therefore, justly criticize the student for his lack of practical knowledge or his theoretical thinking or handling of engineering problems. We should not severely criticize the system of the engineering schools, for many competent engineers have been produced by their methods. It would be better to suggest ways and means to improve the graduates rather than to ridicule and criticize them.

These young men while at college are eager for information of a practical sort. They want to know what will be expected of them and what they may expect from the profession when they finish college. The college men and the self-made men that have made a success in the engineering profession can, through the engineering magazines, do a great good for the engineering students and the engineering schools. If one or two pages of our leading engineering magazines were devoted entirely to the interest of engineering students and schools, it would assist very much in doing away with the prejudice that often exists.

Jacksonville, Fla. J. A. ROBERTSON.

TUBES FOR SURFACE CONDENSERS are usually made of Muntz metal or Admiralty brass. Muntz metal is an alloy of 60 per cent copper and 40 per cent zinc, while Admiralty brass consists of 70 per cent copper, 29 per cent zinc, and 1 per cent tin. The latter costs more but resists corrosion much better, and so is customarily specified when sea water or impure river water is used for condensing.

Buckling of Boiler Tubes

In the Sept. 21 issue E. S. Smail, commenting on my discussion of the buckling of boiler tubes in the July 13 issue, states that the subject is more complicated than I indicated. If this is true, then Mr. Smail makes it so by introducing factors that, I think, do not exist in practice.

I do not believe that the "quality of adhesion" that Mr. Smail assigns to steam exists in any but a negligible quantity in steam boilers working above a nominal capacity. With tubes inclined as they are in steam boilers and with the water velocity resulting from this inclination, it seems to me that "steam locking" is out of the question. What is "steam locking" anyway? Can anyone demonstrate it in a steam boiler that is free from trapping zones, or can it be explained without an excursion into the realm of metaphysics?

Mr. Smail implies that a boiler tube might be caused to arch from the expansion of the upper surface by overheating, which in turn is caused by the insulating effect of a film of adhering steam. I am willing to grant the existence of a bubble of steam which, under favorable conditions might adhere to the top of the tube, but I cannot believe that the entire upper surface of the tube, for its full length, can be covered with a film of steam, which film is necessary to effect the increase of temperature and the expansion that Mr. Smail thinks would cause the tube to arch, or bow upward. Suppose there exists a film of steam that covers the entire upper surface of the tube and that its insulating effect causes the upper fibers to expand, why should the tube bow upward? With the increase of pressure at the tube sheets caused by the expansion of the upper fibers, the tube would be an eccentrically loaded column and would bow in a direction *away* from the eccentricity, in this case, downward. Has anyone ever seen an eccentrically loaded column deflect in the direction of the eccentricity?

Mr. Smail asks, 'What, then, makes them sag?" I never saw a sagging tube in a water-tube boiler, although I have seen plenty of arched tubes. Sagging tubes appear to be a characteristic of fire-tube boilers. The same reasoning that reaches a conclusion for arched tubes of water-tube boilers, also reaches a conclusion for sagging tubes of fire-tube boilers. In the latter case the scale settles on the top of the tube; the upper fibers expand under the rise of temperature; the expansion is resisted by the heads of the boiler which are stayed by the adjacent tubes; the tube is then an eccentrically loaded column, and the deflection is opposite the eccentricity, or downward. C. O. SANDSTROM.

Los Angeles, Calif.

With reference to the discussion on buckling of boiler tubes, the reasoning is correct save in one instance: The natural deflection of the tubes at the time they are expanded into the header was taken into account, and from that point on it is assumed that the tubes are practically beams with fixed ends. However, the tension due to the boiler pressure was then taken into consideration, which is not correct. Before the boiler is placed under pressure it is usually heated, and the tubes will therefore be subjected to a temperature of at least 212 deg. F.; consequently, there will be a greater compression on the upper fibers than was calculated.

It has been claimed by other writers that the top of a boiler tube in the lower row will be hotter than the bottom, but such condition is inconceivable, because the top is not subjected to radiant heat. Besides, the gases go upward, and with their progress they continually drop in temperature; consequently, the temperature of the gases themselves at the top of the tube will be less than the temperature when first touching the tubes. Steam in its generation moves upward, and in boiling it comes in contact with the top side of the tube. In moving upward, steam also drops in temperature. My contention is that in overloaded boilers there is probably no more steam or water in contact with the bottom of the tube than with the top, owing to the violent boiling.

Other things that doubtless have considerable influence in boilers are soot and ash. In water-tube boilers soot and ash have a tendency to settle on the tops of the tubes, thus giving an insulating effect. Hence the heat is partly kept away from this part of the tubes. This increases the tendency to buckle upward, the soot being on the outside of the tube while the scale is inside, the soot keeping the heat away from the tube, and the scale keeps the heat away from the water.

In fire-tube boilers the soot is inside the tubes at the bottom, and the scale lies outside the tubes, at the top, hence the higher temperature attained by the tops of the tubes in water-tube boilers.

It seems that with this additional agreement of theory and fact, together with the various analyses that have been published in *Power* in which nearly everything else has been considered, we come pretty close to knowing why the tubes in water-tube boilers buckle upward and why, in fire-tube boilers, they buckle downward.

Atlantic Highlands, N. J. M. M. GOOCH.

Aligning Long Shafts

Referring to the article on using fine steel wires for aligning shaft bearing on page 440 of the Sept. 21 issue, I have always tried to avoid any uncertainty as to the tension in the wire, such as might result from the bearings of the spool and the guide sheave and from the bending of the wire. Consequently, I have used a spring balance to stretch the wire; this is a simpler and more portable rig than the spool and frame.

By the drawing the wire was 0.018-in. diameter on a 3½-in. diameter spool, and the 27¾-lb. weight acted at a 3½-in. radius, so if this rig was frictionless, the pull on the wire would be 55½ lb., or over 200,000 lb. per sq.in. of wire section.

By blotting the given deflections at the middle of the span at the given tension for the different spans given, the spots form a fairly straight line, and the deflection at the middle of the span varies as the span in feet × 2.15, or the equation would be:

$$\textit{Deflection at center in inches} = \frac{2.15 \times \textit{span in feet.}}{95{,}700}$$

Evidently, a very small difference in the tension or weight of the wire for a given end pull would greatly affect the control deflection, and that is why I believe that most men want to know in each case what the actual central deflection is.

Comparing the rise of the wire as given in the table at any point from the center of the span instead of the drop from the end of the span, I find that the figures indicate that it increases almost exactly as the square of the distance from the center, which indicates that for all practical purposes in lining shaft bearings by this table, the wire forms an arc of a circle for the small angle here formed and extremely long radius of the arc.

Birmingham, Ala. F. W. SALMON.

A new slant on things observed in and out of the power plant

What Happens and Why?

A Simple Experiment with CO_2

IT IS safe to say that there are very few power-plant engineers who are not familiar in a general way with the meaning of the word CO_2 and its significance in boiler operation. There are, however, many who are not provided with CO_2 recorders and have never even had the opportunity to make use of an Orsat apparatus. Some of these may be interested in a simple experiment by which the presence of CO_2 in flue gas may be demonstrated and the amount roughly estimated.

The apparatus may be made in a couple of hours without spending more than a few cents for equipment, as most of the parts can be assembled from material on hand in every power plant. Most of the construction details will be clear from the sketch. The small glass tubing can be bought straight and then bent by heating it in a bunsen flame or gasoline torch. The tube is rotated continually between the fingers while the flame plays upon the spot where the bend is to be made. When the tubing is sufficiently soft it is removed from the flame and bent quickly to the desired shape. The bend is then smoked in a candle flame and allowed to cool very slowly to avoid strain.

If it is desired to estimate the amount of CO_2 in the flue gas, a small scale should be pasted on the side of the gage glass. This scale is graduated to read from 0 to 20, and the divisions are so spaced that each reads the actual percentage of the total distance from the zero mark up to the bottom of the stopper at the top of the tube. That is, if the distance from the scale zero up to the bottom of the stopper is 10 in., the divisions would be so spaced that it would be 2 in. from the zero up to the 20 per cent mark.

The arrangement of nozzles, nipples and caps shown at the right serves as an aspirator to draw the flue gas from the flue and through the apparatus. If this aspirator were to be used continuously, as in a commercial CO_2 machine, some attention would have to be given to its scientific design. Since it is to be used occasionally only for experimental purposes, economy in steam consumption is no object. It is only necessary to make sure that it produces a suction in the attached pipe slightly in excess of the draft in the flue at the point where the sample is drawn.

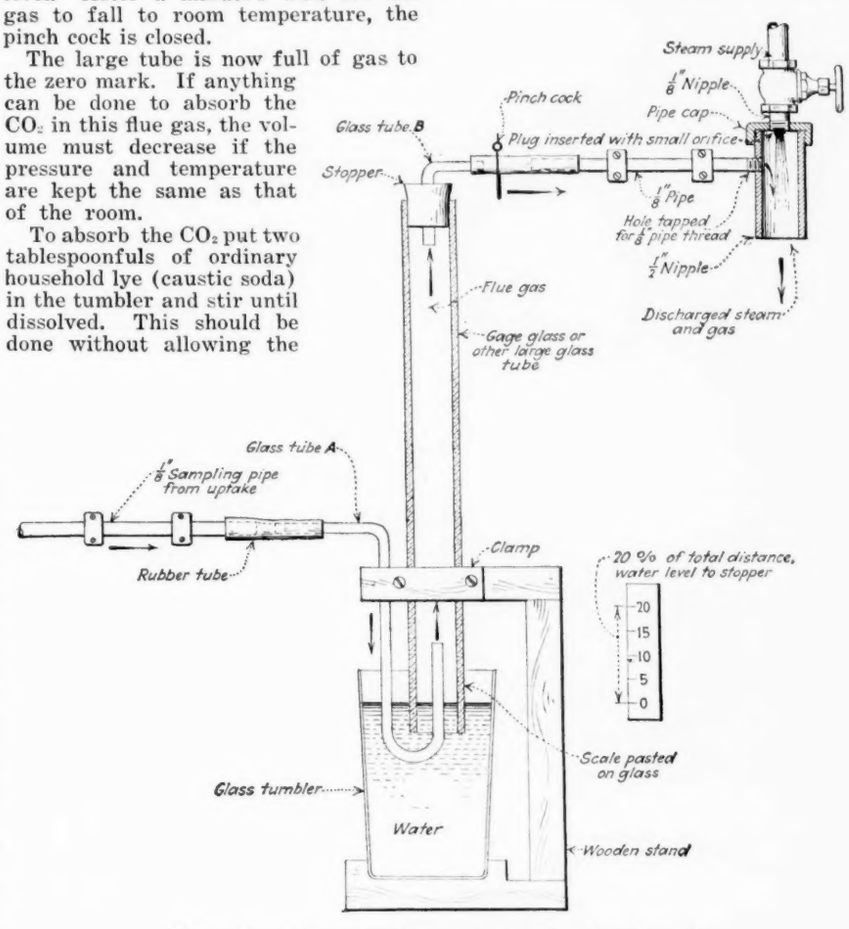
The apparatus being connected up as shown, but with the pinch cock open and the steam supply shut off, water is poured into the tumbler until it rises to the zero mark on the scale. Then the steam is turned on in the aspirator, producing a steady flow from the flue through the apparatus. This should be continued for at least five minutes to remove all the air from the large tube and make sure that it is full of flue gas. When this condition has been reached the steam is shut off and the bent tube *A* is lowered, moved to one side and lifted out of the tumbler. The water will now fall back to the zero level. After a minute's wait for the gas to fall to room temperature, the pinch cock is closed.

The large tube is now full of gas to the zero mark. If anything can be done to absorb the CO_2 in this flue gas, the volume must decrease if the pressure and temperature are kept the same as that of the room.

To absorb the CO_2 put two tablespoonfuls of ordinary household lye (caustic soda) in the tumbler and stir until dissolved. This should be done without allowing the bottom of the large tube to become unsealed. Then let the whole affair stand for about ten minutes for the CO_2 to absorb. The absorption will be much slower than in an ordinary Orsat, on account of the small surface of liquid exposed to the gas. It may be speeded up by shaking the large tube around in the liquid a little, but care should be taken not to lose any gas or let any air in.

The absorption of the CO_2 will cause the water to rise in the tube. However, it would be an error to read the level of the water on the scale directly as the percentage of CO_2. Before reading is taken, the level of water must be the same inside and outside of the tube. This assures measuring the volume at atmospheric pressure, corresponding to the pressure at which the original volume was measured. The levels can be equalized in two ways. One is to raise or lower the tube in the tumbler until they are same. The other is to pour water into the tumber until the levels are the same. Either method will be satisfactory in this case.

After taking the reading, let the apparatus stand for five or ten minutes more to see whether there is any further change. If so, equalize levels again. When there is no further change in level it may be assumed that all the CO_2 is dissolved. The percentage of CO_2 may then be read directly from the scale.



Experimental apparatus made up of odds and ends

Exchange of Electrical Energy Between Countries

EXPORTATION of power was one of the subjects discussed at the recent sectional meeting of the World Power Conference at Basel, Switzerland. In his paper, an abstract of which is given, Col. William Kelly presented to the conference the situation as it exists between this country and Canada.

POWER has been exported from Canada to the United States ever since the first power houses were built on the Canadian side of Niagara Falls. From the records of power generated and exported from Canada since 1911, it is evident that there has been a marked decrease in the amount of power exported, compared to the use of power in Canada. For example, from all the plants along the international border where power is generated for export, in 1911 these plants exported 67.8 per cent of their output, while in 1926 only 27.5 per cent was exported. In kilowatt-hours exported, there has been an increase from 538,331,425 in 1911 to 1,359,343,753 in 1926.

The Hydro-Electric Power Commission of Ontario, which controls all the plants on the Canadian side of the Falls, with the exception of the Canadian Niagara Falls Power Co. of nearly three billion kilowatt-hours generated in 1926, exported only 19.9 per cent. The commission has an installed capacity of about 850,000 hp. in three plants. Of the power generated in the plant of the Canadian Niagara Falls Power Co., 96 per cent was exported in 1911, in 1926 less than 52.6 per cent, and in 1922 export was as low as 17 per cent, the kilowatt-hours exported in 1911 and 1926 being practically the same, or slightly over 300 million. The power supplied to Canada by this plant increased from about 12 million in 1911 to about 276 million kilowatt-hours in 1926.

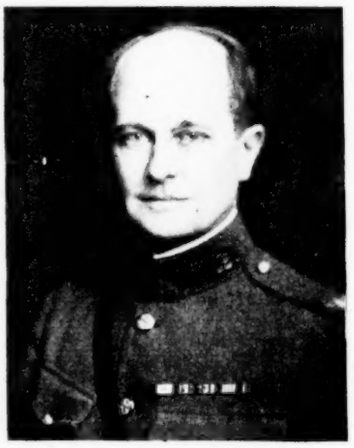
Exported from the United States

Figures on exports of electrical power from the United States into Canada are not available, but the amount has been relatively small. There has been some mutually profitable interchange of power in the Niagara Falls district, but it has been handled mostly through the Canadian Niagara Falls Power Co., which has a plant in Canada owned by United States interests, and the power so interchanged does not directly appear in export figures. There are no laws in the United States relating to export of power, and there has been no indication that such laws will ever be demanded.

The export of power from Canada is controlled by an act to regulate the exportation of electric power and certain liquids and gases. Assented to, April 27, 1907, the act prohibits the construction of lines and the export of electric power, except under license from the Governor in Council. It authorizes the Governor in Council to prescribe regulations governing export of power, including imposition of fees and export duties and obligations to serve Canadian customers ahead of export.

No export duties were imposed under this act until 1925, when the Governor in Council issued a proclamation imposing an export tax of three one-hundredths of a cent per kilowatt-hour on all power exported. For the year 1926 this tax produced $400,000 in revenue.

Inquiries addressed to the four Provinces of Canada, that have exported power, regarding provincial laws relating to export of power, brought replies from three of them to the effect that there were no provincial laws on the subject, as the matter is one that comes entirely under the jurisdiction of the Dominion government. The fourth, the Province of Quebec, however, furnished a copy of Chapter 26, "An Act respecting the exportation of hydro-electric power," assented to March 24, 1926.



Col. William Kelly
Director of Engineering N.E.L.A.

The export of power has been a very live subject in the Province of Quebec for the last few years. The views of those demanding the prohibition of export are quite fully expressed in the preamble of the Act of 1926 as follows:

"WHEREAS, The province contains numerous waterfalls suitable for the development of electric power;

"WHEREAS, By industrial development and the increase in domestic needs, the application of electric power is becoming more considerable every day;

"WHEREAS, Coal, oil, wood and other fuel are daily becoming more difficult to obtain and more expensive;

"WHEREAS, The industrial, commercial and economical development of the Province indicates that in the near future all the water powers which are the most accessible and the least costly to operate will be utilized;

"WHEREAS, Once exportation of electric power is permitted, it can seldom be stopped or suspended without giving rise to serious difficulties;

"WHEREAS, It is in the best economical interests of the province, for the promotion of its industry and commerce, to attract capital and create industrial centers therein in which workmen would find employment, thereby stopping emigration, and in which farmers would find markets for their produce;

"WHEREAS, The prohibition to export electric power in the cases hereinafter determined will constitute an important factor to assist in attaining these objects, and it is therefore, expedient to enact provision to that effect;"

Favors Exporting Water Power

Judging from press reports and technical discussions, there are many in Quebec, and probably more in Ontario, where the subject has also been widely discussed, who do not believe that the prohibition of export of power will have the effect expected by advocates of the act.

The views of those favoring export may be briefly summarized as follows:

1. Water power is valueless until developed. Unlike timber and mineral resources, it is not depleted by use. The earlier it is developed, therefore, the greater the benefit to be derived from it.

2. The feasibility of developing water power is largely dependent upon availability of market. By export a market may be obtained many years before it can be developed at home.

3. Until power is developed and available, it is difficult to attract industries to its vicinity. After it is developed, if there are any industries that can profitably operate in its vicinity, they will have no difficulty in securing a preference over the foreign customers because of the heavy cost of long-distance transmission incident to export.

4. There is no difficulty in curtailing or stopping export, provided the power exported is sold to public utilities on relatively short-term contracts and provided long-term contracts to individual industries are avoided. The recent development of large interconnected power utility companies offers a practicable and flexible market that makes feasible the immediate development of many large water powers that otherwise may wait years for an adequate local market.

5. Canadian laws restricting export

of surplus electric power may bring into being laws taxing or restricting export of coal from the United States to Canada.

6. Operations in Ontario indicate that there are mutual benefits possible from an interchange of power which will be lost if the export of power is prohibited or greatly restricted.

Available Water Power

The table gives the water power available and developed in the four Canadian provinces that adjoin the boundary between the United States and Canada. If the growth of load were to amount to 10 per cent per year, it would take about 23.64 years to develop all the power in Quebec Province.

Canada, with an area of over 3,700,000 square miles, has a population of

AVAILABLE AND DEVELOPED WATER POWER

Province	Available 24-Hr. Power At 80% Efficiency: Ordinary Minimum Flow, Hp.	Available 24-Hr. Power At 80% Efficiency: Six Months Flow, Hp.	Ultimate Turbine Installation Hp.	Present Turbine Installation Hp.	Per Cent Developed
British Columbia	1,931,142	5,103,460	6,635,000	414,702	6.2
Ontario	4,950,300	6,808,190	8,850,000	1,784,842	20.2
Quebec	6,915,244	11,640,052	15,130,000	1,747,386	11.5
New Brunswick	50,406	120,807	157,000	44,631	29

less than 9,000,000 and used about 8,000,000,000 kw.-hr. in 1924, whereas the United States, with an area of about 3,000,000,000 square miles, has a population of over 117,000,000 and used over 54,000,000,000 kw.-hr. in the same period. While Canada has a high per capita use of power, due largely to the pulp and paper industry, the total power used is only about one-seventh of that used in the United States, and twenty-five or thirty years ago, when the export of power started, the ratio was smaller and the total electrical power used in both countries was less than 2,000,000,000 kw.-hr. It is quite logical, therefore, that when the large water powers near the boundary were developed, a market should have been sought in the only place it could be found, namely, the United States.

Early Power Developments

The principal problem for the earlier power developments in Canada, as in the United States, was to find a market. This led in both countries to long-term contracts at very low rates. In several cases, based upon such contracts, large investments were made in industries which required large quantities of cheap power, and naturally these industrial investments make it difficult to modify or terminate the power contracts on which they are dependent. With the growth of higher uses of power in both countries, many of the early long-term contracts have come to be looked upon as undesirable, and some of the sentiment in Canada against export of power doubtless can be attributed to these old contracts, regardless of the fact that the very growth of higher uses of power, which makes the old contracts seem undesirable, makes the use of such contracts unnecessary and improbable in connection with future developments.

In New York and New England less than one-third of the electric power used is supplied by hydro-electric plants, the balance being produced by steam plants. It is possible that this ratio can be maintained for a few years longer by developing the remaining water powers in the United States, but even if there were no restrictions on export of water power from Canada, within twenty or twenty-five years, with the present growth of demand the entire increase of load must be supplied by steam power. The cost of steam power in the principal centers, such as New York City and Boston, is not much greater than the cost of hydro power transmitted from Canada, so the effect of restriction on export of power from Canada, with possible local exceptions, is not likely to be important to the United States.

Economic conditions rarely conform to political boundaries, and it is probable that in some cases, in the future as in the past, an interchange of power between the United States and Canada will offer material economic advantages to both countries. So long as these advantages are more or less theoretical or lie in the future, political considerations may lead to restrictions. If one may judge by the past, however, equitable terms of interchange can be arranged whenever in the future specific cases arise that offer positive and material advantages to both countries.

Utilization of Water Power in Japan

At the recent sectional meeting of the World Power Conference at Basel, Switzerland, S. Mayehara, chief engineer of the Bureau of Electricity, Ministry of Communication, Tokyo, summarized power development in his country. Japan is richly endowed with water-power resources, notwithstanding her small land area. The rainfall normally varies from 60 to about 100 in. per annum, reaching as high as 200 in some places during abnormal years. Most of the rivers are not navigable, therefore the problem of taking care of navigation in water-power developments is not a serious one. Agriculture does not interfere with water-power development, since most all the power sites are in the high lands where the water supply for agriculture is of small importance.

Storage Generally Impracticable

High water in the rivers generally occurs in May, June, September and October, and low water in January, February and August. With a few exceptions, storage of water during the high-flow periods is not possible. There are two large natural reservoirs, Lake Biwa and Inawashiro. The former is utilized by the Ujigawa Electric Co., and the latter by the Tokyo Electric Light Co., each of which has an installed generator capacity of 60,000 kilowatts.

According to the investigations of the Japan government, the total water power available throughout the year is 6,415,000 hp., and for 50 per cent of the time about 14,000,000 hp. In 1924 there were installed about 2,000,000 hp. capacity in hydro-electric plants and 840,000 hp. capacity in steam plants.

The total electric energy generated in 1924 by public-utility power stations amounted to 6,657,000,000 kw.-hr., of which 5,833,000,000 was produced in hydro-electric plants and 824,000,000 was generated by steam and gas-engine plants. No statistics are available for private companies and government plants, but if these were included the total power generation for Japan in 1924 would probably have reached 8,000,000,000 kilowatt-hours.

Engine Was Negligently Started

By Arthur L. H. Street

Permanent maiming of an employee and a lawsuit costing the employer approximately $25,000, were the results of the carelessness of a stationary engineer in turning on steam while the injured man was standing on one of the spokes of the flywheel in assisting to pull the wheel off center, or in failing to turn off the steam after it had been turned on.

The accident is described in the opinion of the Arkansas Supreme Court, lately handed down in the case of Wallace vs. F. Keich Manufacturing Co., 286 South Western Reporter, 815. The court said:

"It was manifestly dangerous to turn the steam on while the employees were engaged in rolling the wheel to get it off of center. . . . Hence . . . it was negligence . . . to turn on the steam, or having previously turned it on, to neglect to turn it off while appellee was helping to roll the flywheel."

The wheel was ten feet in diameter and weighed two tons.

The court also ruled that a verdict of $22,541 in plaintiff's favor was not excessive, $13,833 being allowed for loss of earning capacity and $8,708 for pain and suffering. He lost his right leg, which was almost torn off, and sustained serious and very painful injuries to his other leg, back, etc., leaving him so badly crippled that he will probably never be able to work again.

Petroleum from Water Gas—From Paris comes the announcement that a process has been discovered to manufacture petroleum synthetically from water gas. The inventor, M. Audibert, had previously succeeded in making methyl alcohol synthetically from water gas, and it had been reported that a factory was being built to produce methyl alcohol on an industrial basis, for motor fuel. According to the "Matin," the process consists in compressing water gas, which is a mixture of hydrogen and carbon monoxide, to 2,850 lb., then forcing it at high velocity over a catalyzer. It is probable that some reducing agent must also be used, to absorb the oxygen which does not enter into the composition of petroleum.

News in the Field of Power

Ripley Urges Federal Survey of Utilities Extension

The growth of light and power systems all over the United States has been accompanied by such an overextension of corporate organization, resulting in a complexity of evils, that a sweeping Federal investigation is urged by Prof. William Z. Ripley of Harvard.

In the November issue of *The Atlantic Monthly* he carries forward into this new field his recent attacks on financial tendencies in big business.

"We are irresistibly trending to one or two goals," he writes, "either greater unanimity of state legislation or supersession of state incorporation for interstate business by direct assumption of Federal authority.

"The awkward and even deceitful nature of these involved corporate relationships is fully recognized by responsible managements. Several first-class attempts, in fact, are now under way, aiming at a simplification of overextension."

Specific proposals aimed at either goal, however, are subordinated by Professor Ripley to the necessity first for obtaining "more light."

Asks Unbiased Survey

"The surest source of disinterested illumination would be a comprehensive examination into the whole subject of public utilities," he says, "preferably under the authority of the Federal Power Commission or some other special board temporarily created for the purpose.

"Consequently, a wise policy at this juncture would seem to be to refrain—ostentatiously, as it were—from advocacy of any program; but to urge instead that the President recommend to the Congress that provision be made for such an exhaustive inquiry, to be so prosecuted as to command the confidence of the entire country. The result would be a substantial contribution to the body of our information on a subject of profound importance at this time to some millions of the people of the United States.

"A searching inquiry by real experts, stripped of all political bias and affording a field for all comers; an open contest in which the truth, regardless of self-interest, shall prevail—this is the downright need of the moment."

Argentina To Study Our Water Power Methods

Argentina, having serious problems of flood control with which to deal, has sent Lorenzo Lépori, its director of hydrography, to the United States to acquire direct knowledge of the work which has been done in this country.

In addition Mr. Lépori is familiarizing himself with our hydro-electric and irrigation development. He will spend six months here. The water resources division of the Geological Survey is planning his trip for inspection of the more important flood control works and hydro-electric developments.

A.S.M.E. Announces Program for Annual Meeting

Papers holding much interest for power engineers will form the principal business of this year's meeting of the American Society of Mechanical Engineers to be held at the Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 6-9.

Covering industrial power, two papers will be read Dec. 6: "Relations of Stokers to Boilers," by W. A. Shoudy, and "Allocation of Boiler and Power Costs to Heat and Power," by W. R. Herod.

Other studies by the various divisions of the society are: "Effect of Smoke on Health," Dr. W. C. White; "Smoke Abatement," H. B. Meller; "Present Status of the Smoke Problem," Osborn Monnett; "The Status of Heat Transmission Data and Knowledge in the Refractory Field," P. Nicholls; "Determination of the Thermal Conductivities of Heat Insulation for Temperatures up to 1000 Deg. F. on Other Than Flat Surfaces," R. H. Heilman; "Heat Transmission from Condensing Steam to Water in Surface Condensers and Feedwater Heaters," W. H. McAdams, T. K. Sherwood and R. L. Turner; "Heat Transfer for Forced Flow of Air at Right Angles to Cylinders," W. L. Chappell and W. H. McAdams.

Byproduct processing of coal will be considered Dec. 8, with "Low-Temperature Carbonization of Coal," A. C. Fieldner; "The Distillation of Coal," W. H. Blauvelt; "Complete Gasification of Bituminous Coal," R. S. McBride.

Fritz Medal Award

Thursday, Dec. 9, will be devoted to central station power problems: "The Influence of Radiation in Coal Fired Furnaces on Boiler Requirements and a Simplified Method for its Calculation," W. J. Wohlenberg and E. L. Lindseth; "Operation Performance Modern Surface Condensers," Paul A. Bancel; "Some Results of Condenser Operation," Edwin B. Ricketts. Also oil and gas power: "Kinematics of Cams Calculated by Graphical Methods," H. Schreck; "Two-Cycle Oil Engines," E. C. Madgeburger; "Ideal Gas-Engine Cycles," R. C. H. Heck; "A Temperature-Entropy Diagram for Air and the Diatomic Gases O_2N_2 and CO," H. A. Everett; "The Tangent Method of Analysis for Indicator Cards of Internal Combustion Engines," P. H. Schweitzer.

Of great moment will be the award on the evening of Dec. 7 of the John Fritz Medal to Dr. Elmer A. Sperry, in recognition of his numerous electrical inventions and general pioneer work in that field, but more especially for his gyro-compass. During the same evening session President William L. Abbott will deliver his official address, and the new president, Charles M. Schwab, will be introduced.

Gas Association Pools Half Million for Research

An appropriation of $500,000 for research work to develop and increase the application of manufactured gas to industrial heating processes has been made by the American Gas Association.

The appropriation is to be expended over a period of five years, according to the announcement, and is expected to mark the beginning of a new era both for the gas utility industry and for industrial centers through the decrease in smoke and soot resulting from the use of smokeless fuel.

Increasing use of gas in industry produced the need for scientific research, according to the association's announcement. Fifteen years ago less than 5 per cent of the gas manufactured was used for industrial heating, while at present about 25 per cent of the total output is thus consumed, and more than 21,000 uses for gas have been developed.

The country's yearly consumption of manufactured gas exceeds 400 billion cubic feet. It is estimated that there are in service in the country's homes 10 million gas stoves and 8 million water and space heaters, and that gas-fired house heating units are being installed at the rate of 100,000 a year.

Evidence on St. Lawrence Closed—Ice Problem Up

Definite action by the New York State Water Power Commission on the permits pending before it for development of St. Lawrence River water power has been put over for a future date in November. At the Oct. 25 hearing the evidence was closed.

A date will be set at which final briefs will be received from American Superpower Corp. and the St. Lawrence Valley Power Corp., upon the approval of the members of the commission.

At the last hearing James W. Rickey, hydraulic engineer for the Aluminum Co., and Col. Hugh L. Cooper offered

further evidence in relation to the feasibility of the development from an engineering viewpoint. Colonel Cooper stressed the importance of the ice problem, which will have to be met in construction, and that the commission should be certain that the party to whom a permit is issued will be able to solve this problem.

Erie (Pa.) Engineers Form Local Federation

Comprising upward of four hundred members, the Technical Federation of Erie, Pa., was formally organized recently at a meeting in the Chamber of Commerce auditorium.

For several years agitation has been going on among engineers and allied professional men, and this formation was the result.

"We are starting under very auspicious circumstances," declared George Bach, of the Union Iron Works. "Incorporation will be applied for at once, and the Technical Federation of Erie will take its proper place among technical societies of our country, and also aid in meeting civic and state problems. Included in its membership will be every kind of engineers and technical men, and Erie boasts of a large number."

After a preliminary meeting presided over by R. L. Yates, of the Skinner Engine Co., the directors, composed of representatives from six affiliated branches of engineers, went into session and transacted business which was indorsed by the meeting.

Quarters for a clubroom and library have been secured at the Chamber of Commerce. A large technical library will be built up at once.

Officers for the year include: Chairman, C. Paxton Cody, architect, recently elected president of the State Association of Architects; vice-chairman, J. Frederick Wadsworth, consulting engineer; treasurer, W. H. Pelton, of the Erie Lighting Co.; and secretary, M. W. Ward, of the American Sterilizer Co.

Speakers of national importance will be brought to Erie by the organization.

Supreme Court Holds Strike for Old Claim Unlawful

A strike called without just cause is unlawful, the United States Supreme Court held Oct. 25 in affirming the decision of the Kansas Supreme Court sustaining the conviction of August Dorchy, who as the vice-president of District No. 14, United Mine Workers of America, was found guilty of violating the Industrial Relations Court act of that state.

While the decision did not attempt to define the right to strike generally, being confined to the narrow limits of the case at issue, it is interpreted as of wide importance in clarifying the legality of certain acts of organized labor.

The defendant was charged with calling a strike at a mine of the George H. Mackie Fuel Co. in Kansas in violation of Sec. 19 of the Industrial Relations Court act, which section makes it a crime for an officer of a labor union to use the power and influence of his position to induce another person to violate any part of that act. He was convicted and sentenced to fine and imprisonment, but appealed on the ground that the section undertook to prohibit strikes and thereby violated the personal liberty due process clause of the Fourteenth Amendment.

In the Dorchy case it was shown that the strike was called against the Mackie Fuel Co. because of a dispute between the company and one of its workers, involving payment of wages.

To collect a stale claim due a fellow member of the union who was formerly employed in the business, is not a permissible purpose for a strike, the Supreme Court holds. In its opinion it further declares that to enforce payment of a disputed claim by a strike is "clearly coercion."

Old Edison Lamp Prized As Antiques in Smithsonian

In 1884 Thomas A. Edison shipped some of his first samples of electric lights to Leadville, Colo., and they were recently salvaged from the ceiling of an old local church. Still burning, and in service, they had, however, not broken a world's record for long-time service, as the church served a mining community and was used only once a year, since the supporting population had mostly moved away.

A sample of the lamp type is prized in the Smithsonian Institution and is carefully preserved there. These four burned on, at the annual church service, until an electrical man happened to investigate the church lighting system. He modernized the lighting and salvaged these valuable antiques.

Higher Production and Fewer Accidents—Survey Shows

The American worker is producing more and at less accident cost, an analysis of results obtained in a nation-wide study of safety and production by a special committee of the American Engineering Council indicates, Lawrence W. Wallace, executive secretary of the Council, declared in an address before the sixteenth annual congress of the National Safety Council which met Oct. 25.

Mr. Wallace based his declaration on information from 14,289 plants with 2,250,000 employees. Ten principal industries have been surveyed by the engineers in what is called a wholly new approach to the accident problem to determine the relationship between accidents and production.

"Since the task of compiling the data has not been completed, no definite conclusions or recommendations can be made at this time," said Mr. Wallace. "However, in general, the data that have been analyzed clearly show a marked increase in production per worker during the last five years.

"The trend curves, thus far drawn, also show a reduction in the number of accidents per worker. We are confident that the complete analysis will show that, industry by industry, there has been an increase in production per worker and a decrease in accidents per worker. As management has become more effective, greater production and fewer accidents have been the result."

Permits Granted Washington, Florida, and N. Carolina

Authorized by the Federal Power Commission, a preliminary permit for the City of Seattle will cover a proposed development on the Skagit River in Whatcom Co., Washington. This project is intended to utilize effectively the entire head of the Skagit River between the Canadian boundary and the city's constructed gorge power house.

The estimated capacity of the entire development is 260,000 hp., which is to be realized in three stages as the needs of the city require. The permit is to contain a provision that water must be stored in such a way as to prevent floods below the dam.

The commission has further issued a preliminary permit to Ernest L. Hill and C. Lyman Spencer, of Jacksonville, Fla., covering five sites on the Suwannee and St. Marys Rivers. It is planned to create a large storage reservoir in the Okefenokee Swamp, in which both rivers have their source. Some forty miles of levees will have to be built. The plan calls for dams at Trail Ridge and Traders Hill on the St. Marys and another near its mouth. Two dams are to be constructed on the Suwannee River.

A license has also been authorized for the Carolina Power & Light Co., of Raleigh, N. C., covering a project on Big Pigeon River in Haywood Co. It is proposed to construct a concrete arch dam 130 ft. high, to be raised later to a height of 180 ft. A conduit six miles long will carry water to the power house, where 35,000 hp. is to be installed initially and 70,000 hp. ultimately.

New Hampshire Merger Unifies Five Power Concerns

Public Service Commission of New Hampshire issued an order on Oct. 14, permitting several companies controlled by the New England Public Service Co. in New Hampshire to effect a merger to make up the new Public Service Co. of New Hampshire.

Unhesitating approval of the proposed consolidation was expressed stating that in its opinion the merger would be for the public interest.

The principal companies participating in the merger are the Manchester Traction, Light & Power Co., the Keene Gas & Electric Co., the Laconia Gas & Electric Co., the Ashuelot Gas & Electric Co. and the Souhegan Valley Electric Co.

Over 40 per cent of the population of the state will be served by the merger with electricity, and it will supply gas to cities having a total population of more than 62,000. Forty-five communities, situated principally in the southern part of the state will be served.

Plans for Scientific Study in Petroleum Mature

Following the establishment by John D. Rockefeller of an endowment for petroleum research, a series of studies in the origin, distribution and properties of petroleum is shortly to be inaugurated, under the joint auspices of the American Petroleum Institute and the National Research Council.

A $500,000 fund has already been provided to finance the work for five years. Results will be of the utmost significance as bearing on the present status and future development of the industries based on petroleum, which is still one of the most mysterious of natural resources. Announcement of the projects and of the plan for carrying on the studies has just been made by the American Petroleum Institute.

In view of the current widespread interest in everything concerning petroleum, these inquiries are particularly timely, and certain to be of great practical value, it is declared.

Funds Sought for Princeton Engineering Laboratory

One of the objectives for which funds are being sought by the committee directing the Princeton fund is an engineering laboratory to house the School of Engineering at Princeton University. Present facilities are quite inadequate, it was stated.

The appeal is based on the fact that the engineering course at Princeton differs materially from the courses offered at other universities and technical schools. The trustees of the University granted the request of the engineering alumni for the revision of the old courses, that resulted in the present plan, only on the distinct understanding that Princeton did not intend to compete in engineering with the well established colleges, East and West. It was not their desire to add another standard engineering school to this list, it was pointed out, but they felt that if the fundamentals of the various branches of engineering could be included with cultural subjects they would be willing to establish the other courses.

R. E. Hellmund, A. M. Dudley Advanced by Westinghouse

Two important changes have been made in the Engineering Department of the Westinghouse Electric & Manufacturing Co., according to an announcement by R. S. Feicht, director of engineering. R. E. Hellmund, formerly engineering supervisor of development, has been appointed to the newly created office of chief electrical engineer, and A. M. Dudley, formerly manager of the Automotive Equipment Engineering Department, has been appointed engineering supervisor of development, the position left vacant by Mr. Hellmund's promotion.

Mr. Hellmund's activities in his new position will be principally in connection with electrical development work to assure the adequacy and progressiveness of designs and to co-ordinate this work properly throughout the different engineering departments. He will continue to serve as chairman of the Engineering Educational Committee, and will also retain his connection with the supervisory group on development and the Patent Board.

In the capacity of engineering supervisor of development, Mr. Dudley will be responsible for all central activities of the Engineering Department in connection with the development budget and program of the electrical group. He will continue to act as secretary of the Engineering Educational Committee and secretary of the supervisory group on development.

Newcomen Society Reviews England's Power History

In considering the development of England's industries generally from the technical side there are three great changes to take account of, writes the Newcomen Society of London, Eng., in an article printed in *The Engineer*. First, the introduction of mechanical power in the form of the waterwheel; second, the substitution of the steam engine for the waterwheel; and third, the introduction of pit coal as fuel in place of wood, charcoal or peat.

The introduction of the waterwheel was not due to any desire for economizing human labor, but it had for its object the performance of operations that could not adequately or conveniently be done by men. The use of mechanical power, however, did lead to a very considerable increase in manufacture, to an increase in the number of works and of their size. Still more perhaps would the cost of the machinery, the waterwheel with its pond and leat and the water rights, tend to do this. In some cases, no doubt, the landowner built and owned the mill and leased it to a tenant.

Water Power Limited

In this country the power available at any given spot on a stream is quite limited, so that although larger establishments become possible, the extent of the increase was limited. From one point of view, this was a good thing—it was against the growth of large industrial areas, and works were scattered along the banks of the streams all over the country; but to the manufacturer it was a great drawback. Then the seasons imposed another drawback; in winter the streams were locked by frost, in summer the water supply failed—in either case the mill was rendered inoperative.

Newcomen Pumping Engine

All this was changed by the introduction of the steam engine. It became possible to concentrate all the processes of manufacture in one establishment and to carry on the work throughout the year. The manufacturer, it is true, had to pay for these advantages, the coal bill became a permanent charge on his undertaking. The change was at first a gradual one; it originated with the desire of the owners of water mills to obviate the stoppages of work due to insufficiency of water in the summer months. The Newcomen or atmospheric pumping engine was applied to return the water from the tail-race to the head of the waterwheel. The plan proved advantageous, and as time went on more and more reliance was placed on the engine, until it became the essential element of the combination, and the waterwheel merely a means for producing rotary motion. Then the question arose whether a mechanism could not be contrived to convert the to-and-fro motion of the engine into one of rotation, and thus to dispense with the waterwheel. The problem was solved and the rotative steam engine was produced, and at a critical moment it came into use with amazing rapidity.

Obituary

Dr. Hazen Tyler, of 998 Sterling Place, Brooklyn, assistant professor of mechanical engineering at New York University, died Oct. 27 after a brief illness. He had been associated with the university since 1917. His main work at the university was in organizing the evening division of the engineering section, of which he was director.

Dr. Tyler was engaged during the World War in Signal Corps instruction work. He was a member of the American Society of Mechanical Engineers, a director of the Outboard Motor Industries and associate director of the Popular Science Testing Laboratories at New York University.

Dr. Tyler was born March 21, 1890. He was a graduate of the Brooklyn Polytechnic Institute. He received the degree of Sc. D. from New York University. He also held the degrees of E. E. and M. E. The funeral took place Oct. 30 at the Church of St. Gregory, Brooklyn Avenue and St. John's Place.

Personal Mention

A. C. Pasini has been appointed technical engineer of the Connors Creek Power House of the Detroit Edison Co., a position made vacant some months ago by the death of Julian Harvey.

Major James K. Worth, engineer, previously in charge of plant construction for the U. S. Army, has been placed in charge of the Holding Co. sales by the American Brown Boveri Electric Corp., at 165 Broadway, New York City.

K. M. Irwin, Philadelphia, the engineer who designed the new $3,500,000 power plant of the Sioux City Gas & Electric Co., was a visitor in Sioux City, Iowa, Oct. 18. The purpose of Mr. Irwin's visit was to inspect the new plant to obtain data on its performance after a year of service.

Harold L. Doolittle, chief designing engineer of the Southern California Edison Co., Los Angles, has been appointed chairman of the hydraulic power committee of the National Electric Light Association. Mr. Doolittle was graduated from Cornell in 1906 with the degree of M.E., entering the service of Crane Co. in Chicago immediately.

Resigning that position in 1907, he spent two years in the office of E. S. Cobb, consulting engineer, with offices in Los Angeles. Mr. Cobb during this time was acting as consulting engineer for the Pacific Light & Power Corp. of Los Angeles, in the construction of the Redondo Beach steam plant. In 1909 Mr. Doolittle entered the employ of the Southern California Edison Co. as draftsman, and immediately began the work of designing the original installation of the Long Beach steam plant. In 1918 he was appointed assistant construction engineer of the Edison Co., becoming chief designing engineer Aug. 1, 1926. Mr. Doolittle is also secretary of the Hydraulic Division of the A.S.M.E.

Business Notes

The American Brown Boveri Electric Corp. reports that G. C. Barry has been appointed assistant to E. G. Hines, general sales manager.

The Timken Roller Bearing Co. has appointed Yale D. Hills branch manager of the Seattle office. Mr. Hills was formerly branch manager of the Portland office.

The American Hammered Piston Ring Co. has taken new and larger quarters in San Francisco, located at 677 Folsom Street, which include warehouse as well as offices.

The Graybar Electric Co. has reported the following appointments to the company's legal staff: F. T. Woodward, assistant general patent attorney; R. R. Adams, and H. A. Pattison, patent attorneys.

The Chicago Pneumatic Tool Co. opened its new building located in the central manufacturing district on Iron Street near Thirty-seventh St., Chicago, on Oct. 1. This building is the new home of the Chicago sales and service branch.

The Reading Iron Co. of Reading, Pa., has appointed George E. Tyson, who for the past twelve years has been in the production department, representative in what is known as the Reading territory which includes central New York State and eastern Pennsylvania.

The Chicago Pneumatic Tool Co. announces the establishment of a sales and service branch at El Paso, Tex., in order to serve its clientele in southwest Texas, New Mexico, eastern Arizona and northern Mexico. E. J. Coughlin will be in charge of the El Paso branch, Mills Bldg.

The Chain Belt Co., Milwaukee, Wis., has started work on a new engineering building at its West Milwaukee works. The building will house the steel fabricating and assembly departments, drafting room, and general engineering offices of the contract division of its business. This is the third major unit to be erected on the 59-acre West Milwaukee site and is part of the general plan to move gradually the downtown Milwaukee plant, located at 16th and Park Streets, to the tract at West Milwaukee.

Robert J. Anderson, Inc., has formed to operate as a commercial testing laboratory, specializing in metals and alloys. The new laboratory, which is situated at 2416-38 Beekman St., Cincinnati, Ohio, is equipped for chemical analysis, mechanical testing, metallography, heat treatment, and radiography.

Coming Conventions

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 6-9. Dr. Calvin W. Rice, secretary.

American Society Refrigerating Engineers. Annual meeting will be held at Hotel Astor, New York City, Dec. 7-9. Wm. H. Ross, secretary.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman, Morgan Bldg., Buffalo. First International Welding Exposition will be held in conjunction with meeting.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Annual meeting Jan. 18. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que.

National Association of Practical Refrigerating Engineers. Annual Convention and Exhibition at Kansas City, Mo., Nov. 2-5. Edward H. Fox, secretary, 5707 W. Lake St., Chicago, Ill.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

National Marine Engineers' Beneficial Association. Fifty-third annual convention at Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Society of Naval Architects and Marine Engineers. Thirty-fourth annual meeting at Engineering Societies Bldg., 29 West 39th St., New York City, Nov. 11 and 12. T. J. Kain, assistant secretary-treasurer.

Trade Catalogs

Uniflow Driven Compressors — The Frick Co., Waynesboro, Pa., manufacturers of ice machinery. This illustrated Series B, No. 9, describes the uniflow engine built by the Frick Co. for direct-connection to its ammonia compressors.

Starting Switch—Allen-Brady Co., electric controlling apparatus, Milwaukee, Wis. Bulletin No. 710 treats of Type J-1552 Form T across-the-line starting switch. The more important features of this switch are dealt with. Approximate dimensions and a price list for 25 to 60 cycles are also given.

Recording Voltmeters — The Bristol Co., manufacturers of recording electrical instruments, Waterbury, Conn. This Catalog, No. 1502, supersedes data on recording voltmeters now found in Catalog No. 1501, recently mentioned.

High Temperature Insulation — The Celite Products Co. This is a printed copy of a lecture on the subject which has been compiled and which is being used by the mechanical engineering departments of a number of the prominent universities throughout the county this year. This lecture goes into the subject of heat losses in general methods of determining heat losses through walls and applications of high temperature insulating materials.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Oct. 25 1926
Pool 1	New York	$3.25@$3.75
Smokeless	Boston	4.33
Clearfield	Boston	3.75@ 4.00
Somerset	Boston	4.00@ 4.25
Kanawha	Columbus	3.00@ 3.25
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	2.60@ 2.75
Pittsburgh gas slack	Pittsburgh	2.00@ 2.25
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.15@ 1.50
S. E. Ky.	Louisville	2.25@ 2.85
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.25@ 3.50
Buckwheat No. 1	Philadelphia	2.25@ 3.00
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Oct. 28, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Oct. 27, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 6.026c. per gal.; 38@40 deg., 7⅜c. per gal.

Pittsburgh—Oct. 19, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Oct. 21, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati — Oct. 26, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Oct. 18, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35@$1.40 per bbl.; 26@30 deg., $1.50@$1.55; 30@32 deg., $1.75.

Boston—Oct. 25, tank-car lots f.o.b. 12@14 deg. Baumé, 4.9c. per gal.; 28@ 32 deg., 6c. per gal.

New Plant Construction

Ark., Corning—Bd. of Commissioners, W. M. Fowler, Pres., will receive bids until Nov. 10 for waterworks improvements including pump house, two pumps, and pumping equipment, 100,000 gal. tank on 100 ft. tower, etc. for Improvement Dist. 1. Estimated cost $60,000. J. R. Rhyne, is engineer.

Calif., Beverly Hills—W. B. McCarty, 1424 Wilshire Blvd., awarded contract for the construction of an 8 story apartment to Simpson Construction Co., Bank of Italy Bldg. Estimated cost $1,250,000. Steam heating and refrigeration systems, elevators, etc. will be installed.

Calif., Los Angeles—Southern California Athletic Country Club, Consolidated Bldg., is receiving bids for the construction of a 13 story club building including steam heating and ventilation systems, swimming pool, 8 electric elevators, etc. at Wilshire Blvd. and Coronado and Corondelet Sts. Estimated cost $1,000,000. Meyer & Holler, Wright-Callendar Bldg., are architects.

Calif., Los Angeles—State Societies of Southern California, awarded contract for the construction of a 12 story hotel and office building on Vermont Ave. to Stanley H. Shave Construction Co., 367 North Western Ave. Estimated cost $3,500,000.

Calif., Oakdale—Oakdale Irrigation Dist., plans to purchase air compressor and gunite outfit. Estimated cost $5,000. R. E. Hartley, is chief engineer.

Calif., Porterville—City plans waterworks improvements including pump and motors, at well station on 4th St. Estimated cost $10,000.

Calif., San Bernardino—Southern California Ice Co., 340 1st St., plans the construction of an ice plant. Estimated cost $200,000.

Calif., San Francisco—O. E. Morris, 775 Post St., plans the construction of a 15 story hotel at Pacific Ave. and Gough St. Estimated cost $1,000,000.

Calif., Tracy—Banta-Carbona Irrigation Dist., plans an election to vote $334,000 bonds to increase pumping capacity to 200 sec. ft. by enlarging pump house and installing 60 sec. ft. pumps in lower lifts, etc.

Calif., Ventura—County Water Dist. No. 2, L. E. Hollowell, Clk., is receiving bids for 2,400 g.p.m. centrifugal pumps and two 15 hp. motors with necessary fittings.

Calif., Visalia—Tulare County, G. Stewart Clk., will receive bids until Nov. 23 for the construction of a hospital, power house, refrigeration plant, etc. Estimated cost $150,000. Kump & Johnson, Rowell Bldg., Fresno, are architects.

Conn., Norwich—Electric Dept., 34 Shetucket St., awarded contract for the construction of a hydro-electric plant to Peck McWilliams Co., 47 West Main St. Estimated cost $40,000.

D. C., Washington—Bureau of Yards & Docks, Navy Dept., L. E. Gregory, Ch. of Bureau, plans the installation of a 150 kw. engine driven d.c. generator in Naval Hospital.

Ill., Chicago—S. Minchin, 53 West Jackson St., Archt., is receiving bids for the construction of an 8 story apartment for Blackstone Building Corp. Estimated cost $600,000.

Ill., Chicago—New York Central R.R. Co., 143 Liberty St., New York, N. Y., awarded contract for the construction of a power house to H. A. Petres Co., 19 South La Salle St., Chicago, Ill. Estimated cost $18,000.

Ill., Chicago—Wacker-Wells Building Corp., A. F. McKeown, Pres., 310 South Michigan Ave., is having plans prepared for the construction of a 23 story office and stores building at Wacker Dr. and Wells St. Estimated cost $6,000,000. Zachory T. Davis, 400 North Michigan Ave., is architect.

Ill., Decatur—A. E. Staley Mfg. Co., will build an office building and power plant. Estimated cost $500,000. Work will be done by owner's forces.

Ill., East St. Louis—Carter Bros. Inc., 720 South 6th St., awarded contract for the construction of an ice plant at 6th St. and Illinois Central R.R. track, to Fruin-Colnon Construction Co., Merchants Laclede Bldg., St. Louis, Mo.

Ind., Fort Wayne—Fox Realty Co., 604 West Wayne, awarded contract for the construction of an 8 story hotel and theatre building at Harrison and Jefferson Sts. to Buesching-Hagerman, 402 East Superior St. Estimated cost $1,250,000.

Ia., Council Bluffs—City had plans prepared for extensions and improvements to pumping station including 3 horizontal centrifugal pumps, etc. Estimated cost $148,-394. Boyd Walker, is city engineer.

Ia., Denison—City plans improvements to waterworks including new wells, etc., installing two new water tube boilers with stokers, etc. Estimated cost $30,000. L. Higgins, 420 Securities Bldg., Des Moines, is engineer.

Kan., Topeka—St. Mary's College, is having plans prepared for the construction of a power plant. Estimated cost $50,000. S. A. Sulentic Consulting Engineering Co., Inc., New England Bldg., is engineer.

Me., Farmington—Ted Toy-Lers, Inc., 55 South Water St., New Bedford, Mass., is receiving bids for the construction of a factory, boiler house, etc., here.

Md., Baltimore—Bd. of Awards, City Hall, will receive bids until Nov. 10 for the construction of a 13 story office building at Holliday, Lexington and Guilford Sts. Estimated cost $1,600,000. W. H. Emory, 18 East Lexington St., is architect. H. Massart, 328 North Charles, is engineer.

Minn., St. Paul—National Lead Battery Co., 1728 Roblyn Ave., plans to purchase a 50-kw. generator set, 75 hp., 3 ph., 60 cy., 220 v., a.c. motor direct connected to a 50 kw., 250 v., d.c. generator.

Mo., St. Louis—William Fox Film Co., 55th St. and 10th Ave., New York, N. Y., will receive bids about Nov. 1 for the construction of a 15 story theatre and office building including steam heating, cooling and ventilation systems, elevators, etc. at Grand and Washington Blvds., here. Estimated cost $5,000,000. C. H. Crane, E. G. Kiehler and B. A. Dore, 400 Huron Bldg., Detroit, Mich., are architects.

Neb., McCook—City will receive bids about Nov. 15 for waterworks improvements including wells, pumps, tank on tower, etc. Estimated cost $45,000. Bruce & Grupe, 710 Bankers Reserve Life Bldg., Omaha, are engineers.

Neb., Stamford—Village, R. E. Weare, clk., rejected bids for one 60 g.p.m. single stroke and one 60 g.p.m. two stroke deep well pumps, one 10 hp., 3 ph., 220 v. a.c. motor. Henningson Engineering Co., National Bldg., is engineer.

N. Y., New York—Bronx Hospital, S. Minskoff, Chn. of Bldg. Committee, 2382 Grand Concourse, had plans prepared for the construction of a 5 story addition to hospital at 169th St. and Fulton Ave. Estimated cost $750,000. L. A. Abramson, 46 West 46th St., is architect.

N. Y., New York—Fourth Garden Plan Corp., K. P. Walker, Pres., 385 Madison Ave., awarded contract for the construction of a 15 story apartment including 4 electric elevators, etc., at 327 East 57th St., to J. K. Turton & Co., Inc., 101 Park Ave. Estimated cost $650,000.

N. Y., New York—Thirty West Ninth St. Corp., c/o Gronenberg & Leuchtag, 1385 Broadway, Archts., is having plans prepared for the construction of a 10 story apartment. Estimated cost $600,000.

N. Y., New York—Zimmet Realty Co., c/o Gronenberg & Leuchtag, 1385 Broadway, Archts., is having plans prepared for the construction of a 15 story apartment including 4 electric elevators, etc. at 313 West 86th St. Estimated cost $1,500,000.

N. Y., Syracuse—Bando Realty Corp., J. J. Banker, 34 Nassau St., New York, awarded contract for the construction of a 22 story office building at Genesee and Water Sts., here, to J. H. Taylor Construction Co., 31 Union Sq., New York. Estimated cost $1,000,000.

Okla., Blackwell—Atchison, Topeka & Santa Fe Ry., 80 East Jackson Blvd., Chicago, Ill., is having plans prepared for the construction of a water purification plant including pump house, 221,000 gal. tank on 60 ft. tower, etc. C. F. W. Felt, is chief engineer.

Okla., Yeager—City is having preliminary plans prepared for the construction of a waterworks system including well, deep well pump, tank on tower, etc. Estimated cost $20,000. Engineer not selected.

Pa., Philadelphia—Provident Trust Co., 400 Chestnut St., had plans prepared for the construction of a 14 story bank and office building at 17th and Chestnut Sts. Estimated cost $500,000. Rankin & Kellogg, 1805 Walnut St., are architects.

Tenn., Crossville—City plans an election Nov. 19 to vote $60,000 bonds for the construction of a waterworks system including deep well pumps, etc. Engineer not selected.

Tex., Amarillo—Southwestern Public Service Co., awarded contract for the construction of first unit of power plant including 836 hp. boilers, 5,000 kva. turbine, 8,600 sq.ft. condenser with auxiliaries, etc. to Day & Zimmerman, 16th and Walnut Sts., Philadelphia, Pa. Gas to be used as fuel. Total estimated cost $1,500,000.

Tex., Beaumont—J. F. Guudhue, Colder Rd., will soon receive bids for the construction of a 12 story office building at Pearl and Crockett Sts. Tisdale, Stone & Pinson, Independent Bldg., Nashville, Tenn., are architects.

Tex., Brownsville—City voted $40,000 bonds for improvements to electric light plant. New machinery, engine, etc., will be required.

Tex., Commerce—Louisiana Ice & Utilities, Inc., W. F. Corl, Pres., Security Bldg., St. Louis, Mo., is having plans prepared for the construction of a 35 ton ice plant, here. Estimated cost $60,000. G. E. Wells, Security Bldg., is engineer. Electrically-driven machinery will be required.

Tex., Denton—Water & Light Dept., H. T. Brewster, Supt., will soon receive bids for improvements to water and light plant, including a 350 hp. gas engine, etc.

Tex., Ennis—Ennis Ice Co., is having plans prepared for the construction of a 30 ton ice and cold storage plant. Estimated cost $15,000. Private plans.

Tex., Inez—W. Koontz, is having preliminary plans prepared for the construction of a cotton gin to replace fire loss. Estimated cost $35,000. Electrically-driven engine, 8 stand 80 saw capacity will probably be required.

Tex., Martinsville—Texas Public Utilities Co. Interurban Bldg., Dallas, plans to rebuild ice plant here to increase the capacity to 60 ton. Estimated cost $75,000. New machinery will be installed.

Tex., Point Isabel—Valley Electric & Ice Co., Harlingen, is having plans prepared for the construction of a 40 ton ice plant here. Estimated cost $60,000. New machinery will be required.

Tex., Wichita Falls—W. McKenzie, Sr., W. McKenzie, Jr., and R. H. Roark, will build a 60 ton ice plant by day labor. Estimated cost $100,000. Private plans. Machinery contract awarded.

Wis., Wales—State Bd. of Control, A. W. Bagley, Secy., Madison, is having plans prepared for the construction of a power plant at State Sanitarium here. Estimated cost $50,000.

Ont., Hamilton—City Council, plans an election soon to vote $520,000 bonds for extensions and improvements to waterworks including pumping equipment to double present capacity. W. L. McFaul, City Hall, is engineer.

Ont., Windsor—A. K. Davis, Victoria St., awarded contract for the construction of a 15 story hotel on London St., to Otto Misch Co., 159 East Columbia St., Detroit, Mich. Estimated cost $1,500,000. Steam heating system will be installed.

N. Z. Wellington—Dept. of Public Works, Supplies & Tenders Board, will receive bids until Feb. 15 for three kva. single ph. transformers and accessories.